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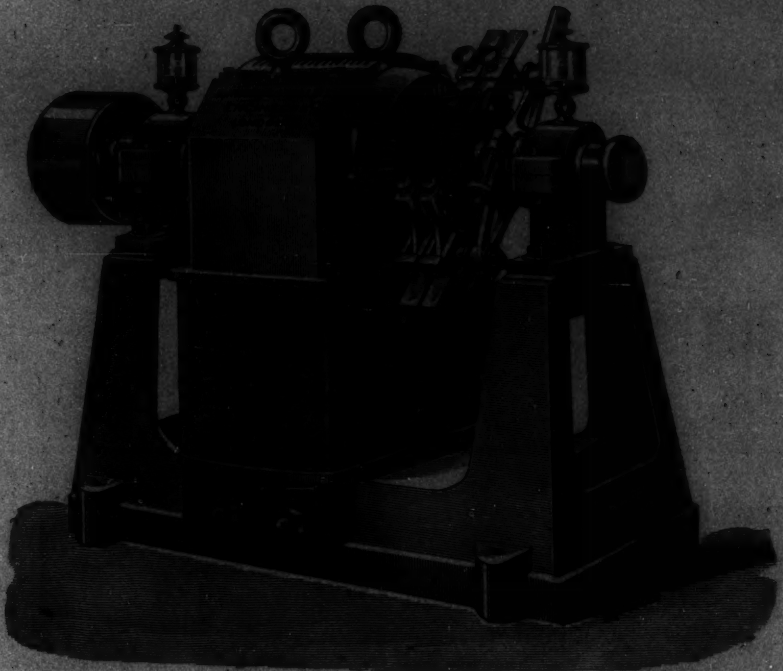

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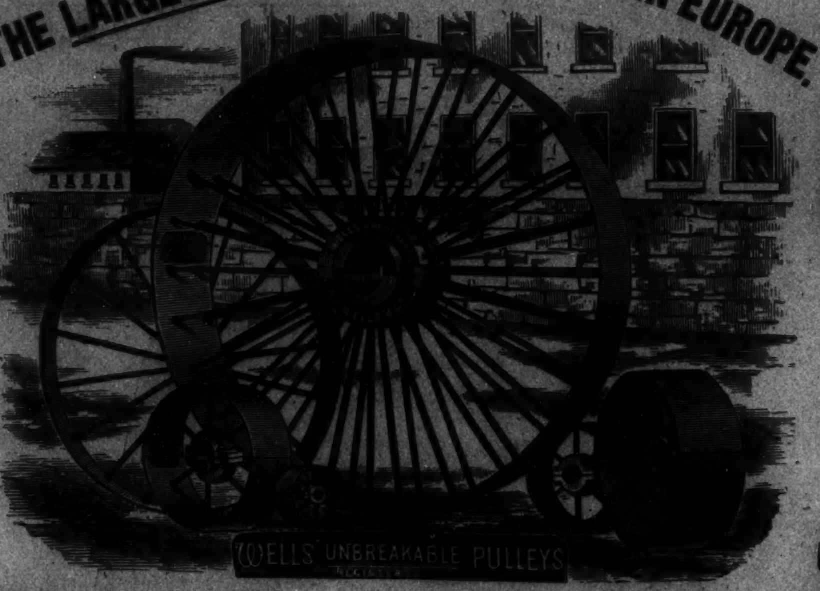

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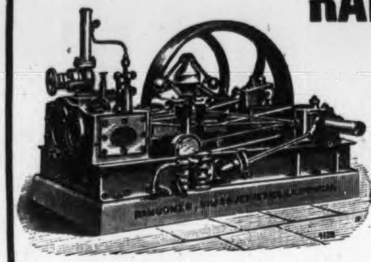

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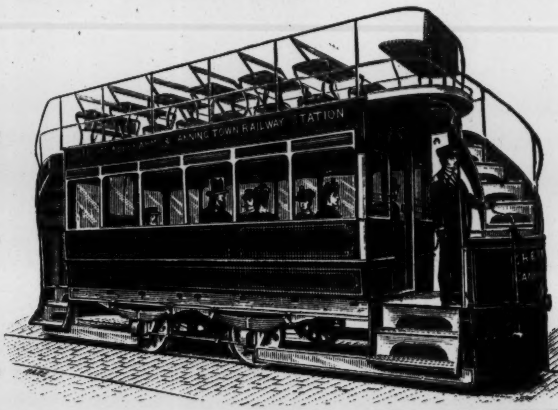

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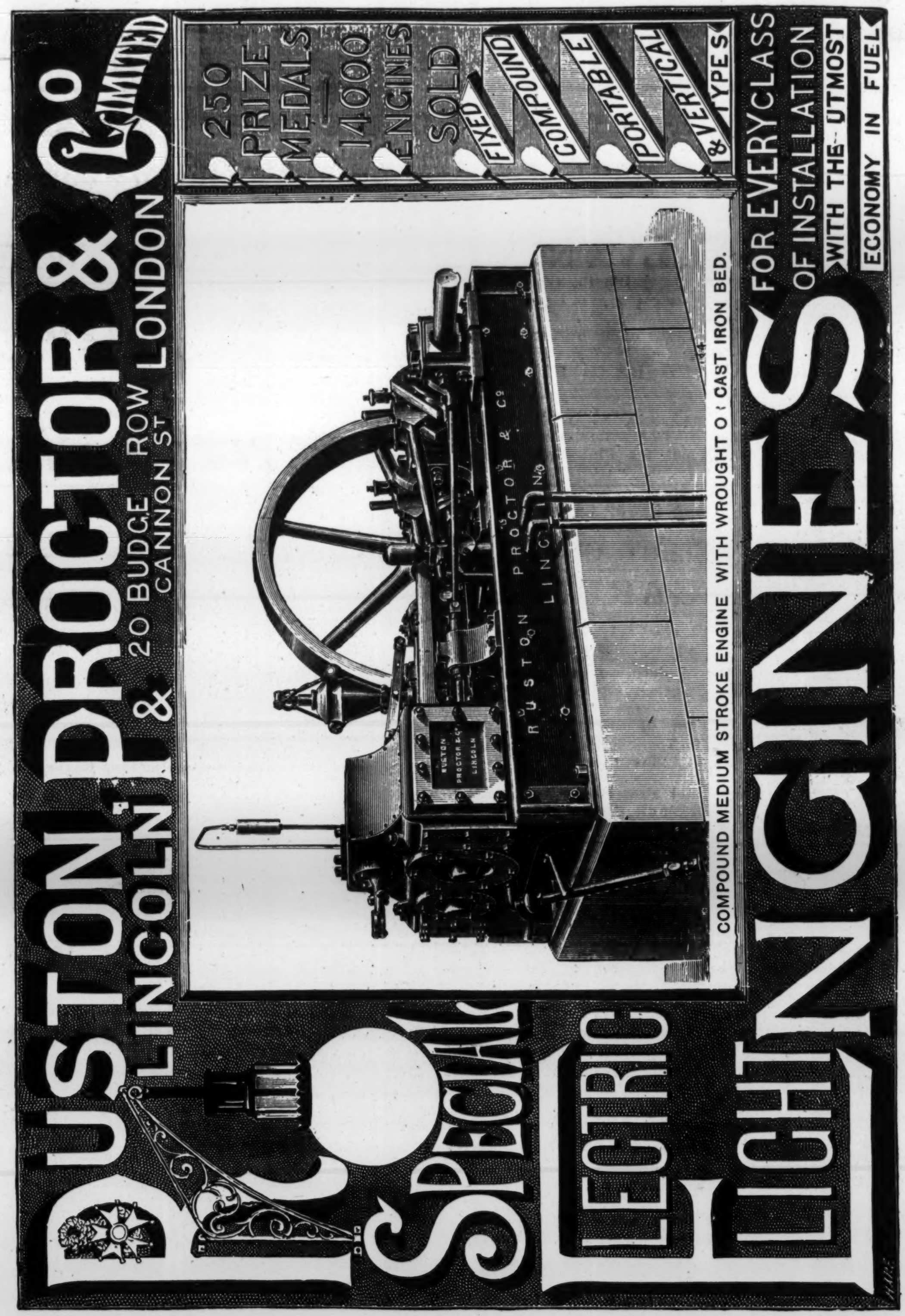
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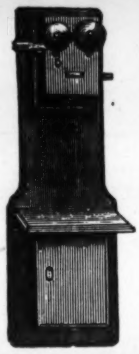

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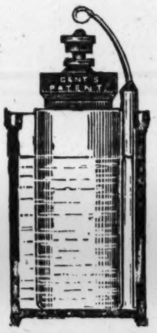

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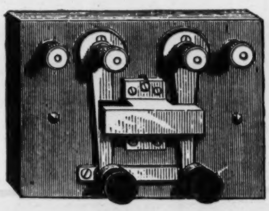

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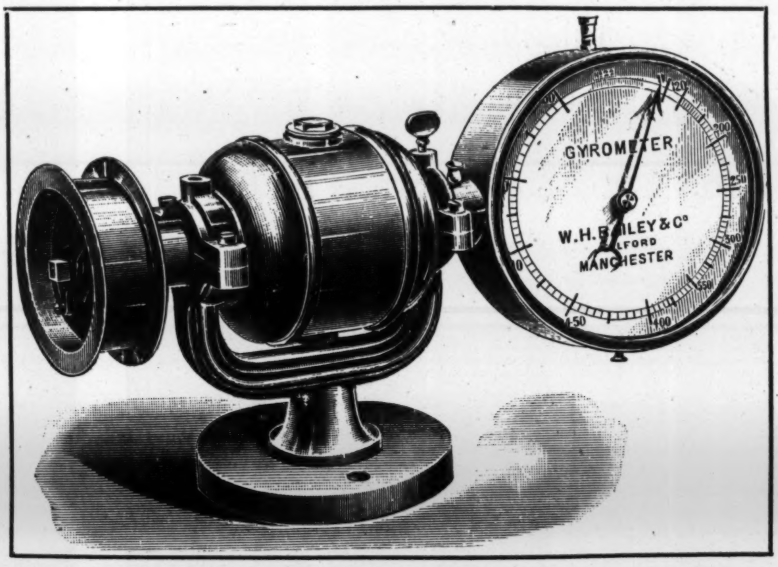

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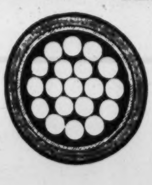

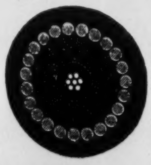

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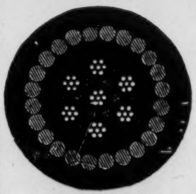

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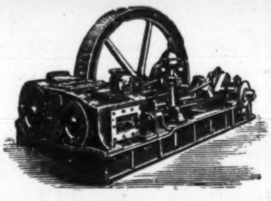

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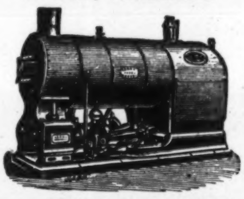

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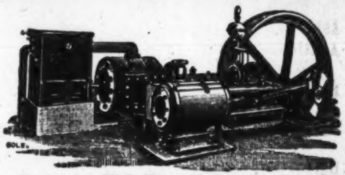

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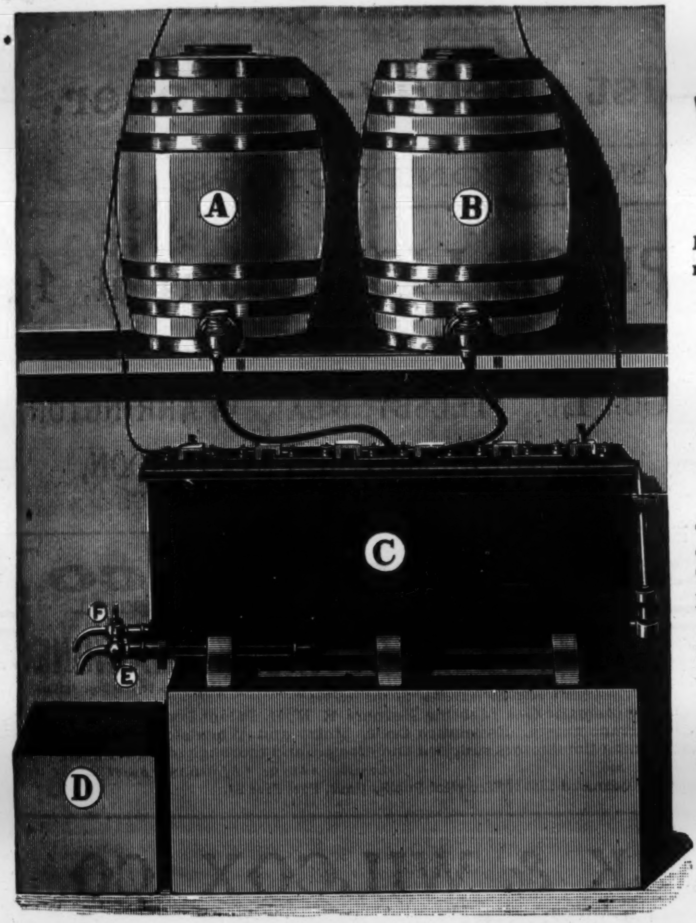

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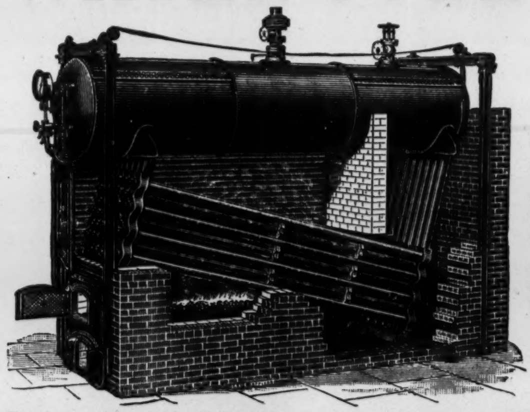

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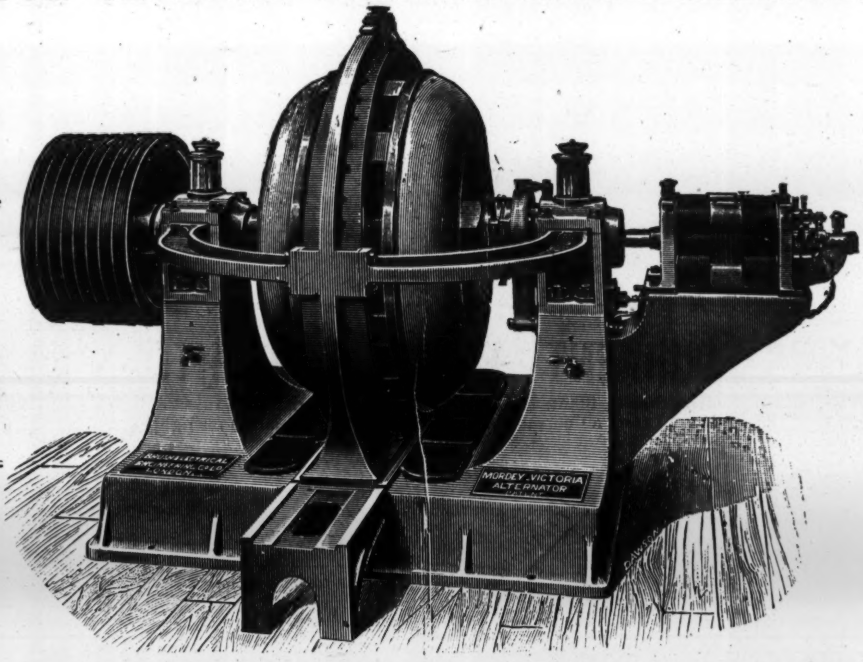

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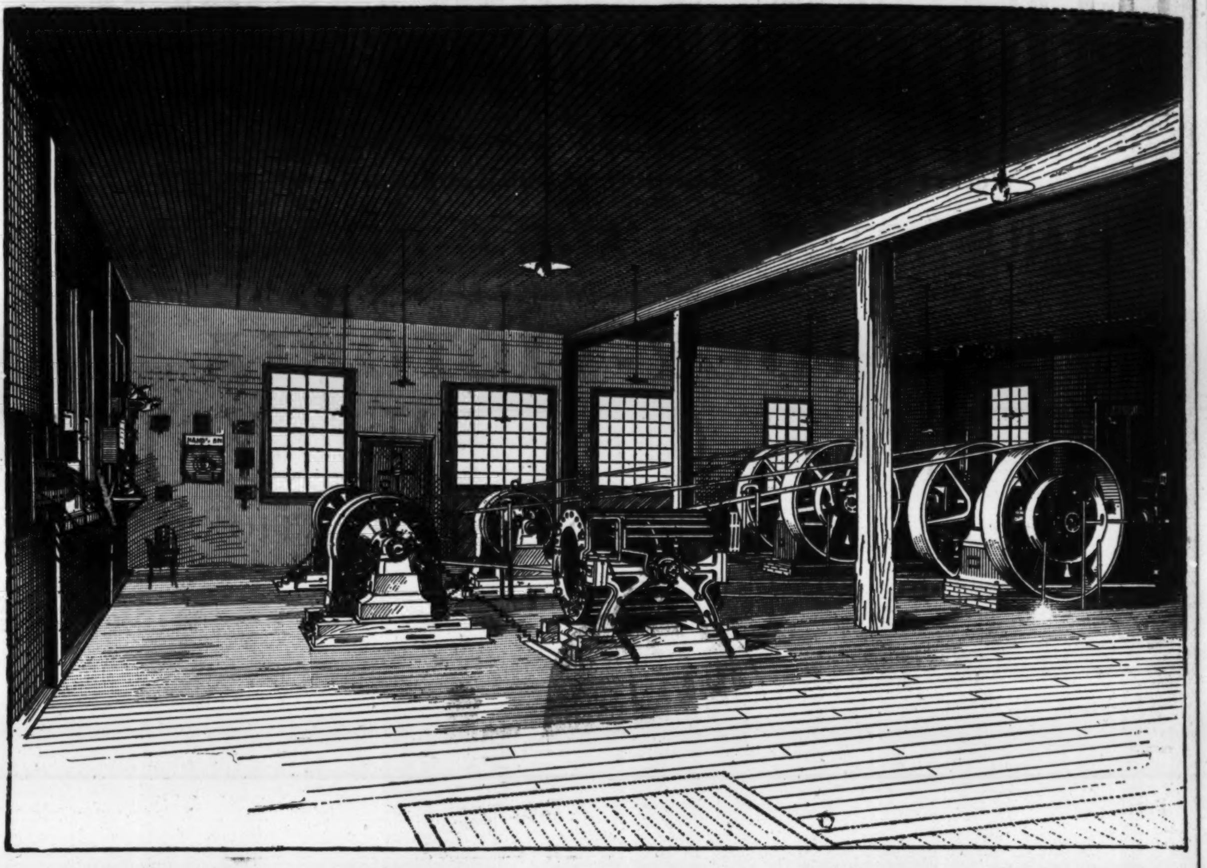

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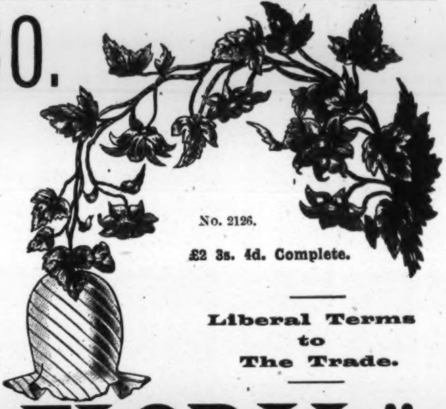

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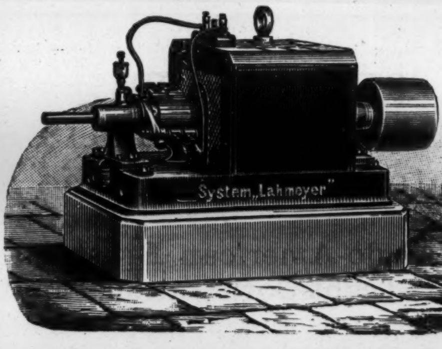

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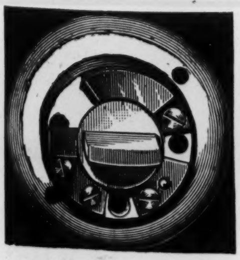

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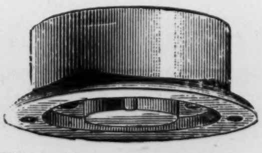

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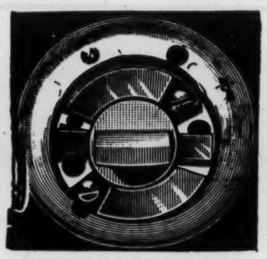

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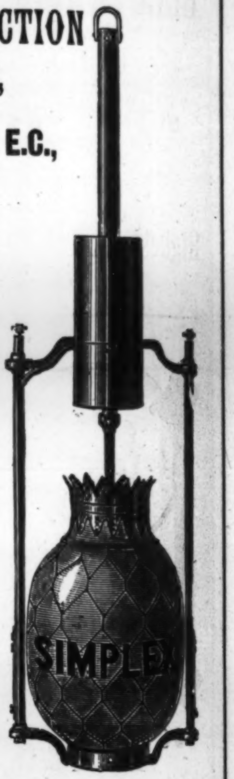

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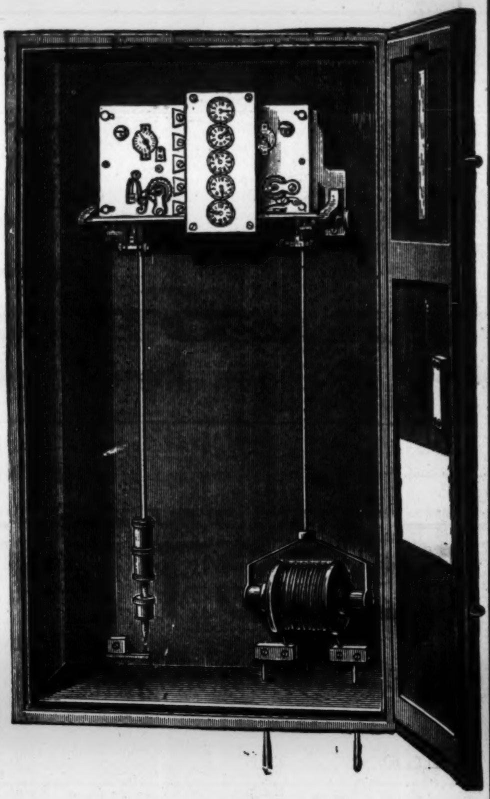

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THE ELECTRO-MAGNET.

PROFESSOR S. P. THOMPSON gave his fourth and final Cantor lecture at the Society of Arts on Monday last, on "The Electro-Magnet." To all who have listened to these excellent discourses it must have occurred that the world knows little indeed about magnetism, and that the recent researches of Hughes, Hopkinson, Ewing, and others, form but the merest fringe of what is yet to be accomplished in this vast and promising field of research. Dr. Thompson is always outspoken, and he revels in an opportunity of upsetting old and generally-accepted notions, called laws. Thus, in his third lecture, he condemned the law of the inverse square of the distance as not merely inaccurate, but as absolutely untrue, if applied to magnets acting upon armatures at reasonable distances, and he emphasised that this law can only hold good in the case of a magnet influencing a point, the point of a needle for instance, at distances which are infinite in relation to the point. This unmitigated condemnation of the law of inverse squares seems to have surprised many of his hearers, among whom were not a few electrical engineers; and yet it must have occurred to hundreds of experimenters and workers in electro-magnetism that this text-book law is absolutely untrue when applied to any magnet acting upon an armature of sufficient dimensions to reach across the poles of, say, a horseshoe; but it appears that not one of them had the courage, or may we say *heresy*, to express his views in the well-chosen and decisive language of which Dr. Thompson is such a master.

Du Moncel, one of the most prolific writers on magnetism, never attempted to contradict the law of inverse squares, nor did he prove it in any single instance. The late Prof. W. A. Miller, however, in the first volume (Chemical Physics) of his excellent "Elementary Chemistry" (a book, by the way, which though not modern, is still most excellent of its kind") says: "This diminution of effect takes place much more rapidly than in the ratio of the square of the distance from the magnetic pole, but the exact law has not yet been ascertained;" and, again, J. T. Sprague in his book on "Electricity," indicates that "this law only applies to each point of a magnet regarded by itself; practically no distinct law can be laid down, as the force is a compound action: it is not governed merely by the distance of the attracted body from the magnetic poles, but by the form of the acting 'field of force' between the poles."

The lecturer referred, on Monday last, to a paper read in the year 1857 by Robert Hunt at the Institution of Civil Engineers, wherein certain experiments with electro-magnets are recorded, and there we read that in one case the armature was held up by its magnet, and it required a force of 220 lbs. to separate it; at the distance of $\frac{1}{250}$ of an inch the pull was 90 lbs., at double this distance 50 lbs., and at five times the distance still 36 lbs. The author of this paper, however, which is entitled "Electro-Magnetism," does not refer to the law of inverse squares; he knew probably that to upset this law would perhaps render him liable to suggest another, and it appears from numerous experiments and from Dr. Thompson's utterances that each magnet would probably require a law for itself which might not hold good for any other. Indeed, the millions of electro-magnets which are doing such excellent service for mankind in telegraphy and hundreds of other applications have been devised and constructed without reference to text books or laws and were simply the outcome of experiment and experience.

It seems anomalous that no definite rules have ever been laid down for the construction of electro-magnets in general. Anyone who requires an electro-magnet for a specific and novel purpose has to go through endless experiments in arriving at what will be best suited for that purpose. Inventors and makers of telegraph instruments, of measuring instruments, of arc lamps, electric bells, and countless other contrivances know to their great cost that the combined literature on electro-magnetism, as it exists to-day, cannot help them in determining with reasonable certainty the size and shape of an electro-magnet for any new purpose. Nothing, beyond some very superficial grouping of special cases, also enumerated by Prof. Thompson, seems to be known about the properties of solenoids upon iron cores; thus the subject of electro-magnetism is still shrouded in great mystery, and Mr. W. H. Preece, when moving the vote of thanks usual at the conclusion of a series of Cantor lectures, hinted that the text-books on this subject must be entirely re-written, and that the discourses just finished would form an excellent basis for a new treatise, just as the Cantor lectures on dynamos, also given by Dr. Silvanus Thompson at the Society of Arts, formed the substance of the best book he knew of regarding that branch of electrical engineering.

Steam engines were made long before Pambour wrote a treatise, long before the laws of expansion of steam, latent heat, or mechanical equivalents were known or understood. Similarly, dynamos were made and used in numbers before the words permeability and hysteresis were applied to magnetic properties; but substantial progress and perfection is generally attained after certain laws are formulated, experimental results tabulated, and the said laws proven; therefore we would gladly encourage the professor and theorist who takes the pains, and has the capacity, to formulate guides for future use, and Prof. Thompson is, in this sphere, one of the brightest and one of the most lucid writers of the age.

PROFESSIONAL ETIQUETTE.

ON Friday night, last week, a public meeting was held in the Town Hall, Brighton, for the purpose of passing a resolution expressing an opinion that the scheme of electric lighting proposed to be carried out by the Council is an experimental one, and must necessitate the expenditure of a much larger sum than the committee now proposed (£30,000), and will involve an enormous waste of the ratepayers' money. On the platform were Mr. Killingworth Hedges and Mr. F. Ince, of London; and on these two names only do we propose to comment.

It is well known to readers of the ELECTRICAL REVIEW that Mr. Shoolbred, who, no matter what opinions may be held as to his competency for the task, has prepared an elaborate estimate for establishing central station lighting in the "Queen of Watering Places," and we may readily take it for granted that his experience in this particular kind of work is certainly in no way inferior to that of his censors. One of these gentlemen does not need any recommendation from us, and may be taken as a professional authority on electric lighting; the other can scarcely be considered except as an amateur whose love of science, to use his own words, brought him into contact with Mr. Ferranti. A third electrical engineer, who was expected to put in an appearance, very justly stated that he could not be present without committing a breach of professional etiquette; and, to his credit be it said, Prof. Forbes took no part in a meeting called to protest against "a monstrous act of injustice," as one virtuous gentleman termed it. Whether Mr. Shoolbred's estimate is right or wrong does not, for the nonce, concern us; and we shall, therefore, confine ourselves to what we consider an act, not only of unfairness towards Mr. Shoolbred, but of what we know will be considered, at all events in electrical circles, of an unprofessional nature, for even the chairman asserted that he believed professional etiquette had militated against a large amount of expert opinion being forthcoming.

Councillor E. A. Dell said he had much pleasure in moving the first resolution: "That this meeting is of opinion that the scheme of electric lighting proposed to be carried out by the Council is an experimental one, and must necessitate the expenditure of a much larger sum than the amount now proposed, and will involve an enormous waste of the ratepayers' money." He took it that the Council had no right to go into private enterprises for the purpose of supplying the electric light to houses. This should be left to companies who would speculate with their own money. He hoped they would have some good sound information given to them by the gentlemen who would address them.

Then up rose Mr. Killingworth Hedges, whose remarks we publish on another page, followed by an oration from Mr. Ince.

That these gentlemen should so far have forgotten what is due to their own self-respect, and to the feelings of their professional brethren, passes our comprehension, and we feel assured that the profession generally will be with us in protesting against making public meetings the platform for levelling damaging criticisms upon the work of others.

Let the Brighton Town Council by all means take the opinion of Sir William Thomson, or some other equally eminent engineer; but, let the members be assured that they are being advised by one who has not a "system" to advocate. The best method of settling this question would be to make it a matter for an expert enquiry, then the advocates or opponents of Mr. Shoolbred's scheme could argue to their hearts' content; as it is, it seems likely that much valuable time will be wasted in mere squabbling between the rival sections who so intelligently minister to the welfare of the town, for what other result can be expected when Councillor Dell, who moved the first resolution, frankly stated to his audience that he was not an electrician, and knew no more of dynamos than they themselves.

Transformer Insulation.

THE question of insulating transformer wires is one which apparently has been somewhat neglected up to the present, but at least one gentleman well known for his writings on these apparatus is giving very serious attention to the matter. When transformers are used in the open they are exposed to temperatures varying from below freezing point in winter to a heat which can only be estimated if one takes the trouble to measure the resistances of the coils. To the hand the outside may appear not to be heated to a dangerous degree, but inside how different is the case! It is therefore not an easy matter to find a method of insulating the coils not only from one another, but each convolution of the primary from its neighbour, and we are quite convinced that what we have previously said about the trouble to be expected from this difficulty alone has in no degree been exaggerated.

Coad's Battery.

THERE is not much in Mr. Coad's letter which calls for comment and we shall therefore dismiss the subject briefly. Our correspondent, who for many years past has periodically appeared before the public with so-called improvements in primary batteries, should know us sufficiently well to be aware that the mere opinions of experts, unsupported by practical data obtained from tests of the apparatus under discussion, do not, so far as we are concerned, carry any great weight. Moreover, Mr. Coad does not need reminding that we have spoken on the authority of actual experience with his battery and that we have therefore expressed something more than an opinion. Nothing that can be said in these pages can alter facts, and as a counter-challenge we ask Mr. Coad to publish the full results of tests made upon one of his batteries; there would then be no further need for discussing the question at issue. We beg to remind our correspondent that we have never yet opposed any legitimate uses for primary batteries, and when we have spoken in severe terms of half forgotten ideas brought to life again by men who try to lead the public to the belief that they are fitted for operations which could not by any possibility be carried out, can he point to one instance in which the lapse of time has not completely proved our contentions? Nevertheless, if Mr. Coad, or any other inventor for that matter, can persuade colliery proprietors to employ electric miners' lamps he will certainly deserve well, for it seems, so far as can be at present ascertained, that the Llanerch explosion was attributable to naked lights, and that had electric lamps been used the principality of Wales would not now be bewailing the loss of nearly 200 lives.

Compound-Winding.

FROM information which has come to hand, we believe we may state with a considerable degree of certainty, that the appeal case in the recent suit in Edinburgh between Messrs. King, Brown & Co. and the Anglo-American Brush Corporation, will be heard before the end of the month. The result will be looked forward to with much interest in dynamo manufacturing circles.

Fire Risks at a Minimum.

IT appears that matches, the use of which will be curtailed as electric lighting develops, are responsible for about twelve times the number of fires and nearly twice the property and insurance loss that are electric lamps and wires. When the comparison is extended to candles, lanterns and gas, the loss accruing from the employment of electrical energy is small indeed. Some statistics in our "Notes" columns, taken from *Modern Light and Heat*, will be more convincing than any amount of discussion.

The St. Pancras Lighting.

IF it is true that Prof. Robinson, C.E., is to receive £2,000, that is four per cent. on the estimated cost for establishing central stations in the St. Pancras district, if his plan is adopted, and £1,000 for his trouble if not, we can only conclude that the vestry has more money than it knows what to do with. Probably the ratepayers might like to have a voice in the matter, for it seems to us that we could name more than one gentleman of the highest eminence in the electrical world who would gladly have undertaken Mr. Robinson's work at half the fee. It would also be interesting to know what experience the electric light expert to the St. Pancras vestry has had, for, to the best of our knowledge, his name has hitherto been unknown as connected with any large electrical undertakings.

More Expert Testimony.

PROF. REDWOOD in his report on the Coad battery, (See Supplement p. 10) says:—"I have estimated the consumption of zinc in the twelve hours' run of a six cell battery and find that it amounts to about two ounces." On what circuit did he run it, and why should he estimate the consumption when he could weigh the plates before and after the trial? Anybody can estimate the theoretical consumption of zinc, but the heavy loss from local action in a battery of this form can only be arrived at by the differences in weight. It seems incredible that any professional man could have committed himself to such a statement as this; it would be just as rational to say that the zinc consumed was about equal in weight to a lump of chalk. Furthermore he writes:—"For this six-cell battery the cost per twelve hours of production of light may, I think, be stated at from 1½d. to 2d." What production of light? One, two, or 20 candle-power? If Mr. Coad relies upon such unmeaning reports as that from which we quote, then the sooner he retires into the comparative obscurity from which he has just emerged, the better for himself and everybody concerned.

Forgotten Works.

FROM time to time at somewhat long intervals we see forgotten discoveries unearthed and brought more or less prominently before the world. This we fear is not often done with the object of honouring those to whom honour is due, but with some ulterior purpose of a mercenary nature; however, this may be, the fact remains that discoveries which were born, and books written, before their time, lie forgotten and unappreciated at the present day. It would not be a difficult task to show the world how much there has been written which, though antiquated as regards time, is not so as regards value. In our leader, for example, we refer to a book of the late Prof. W. A. Miller, professor of chemistry at King's College, London; the first volume of this work (which consists of three volumes), deals with Chemical Physics, and it puts to shame many a modern production; we cannot too highly praise it, the chapters dealing with magnetism and electricity are especially good and we have again and again found them most useful for reference purposes when modern books have failed us.

ARE ELECTRIC CURRENTS SAFE?

THE *Electric Age*, published in New York, a short time back sent out a number of circulars to prominent electricians throughout the States, containing a series of questions pertaining to the important subject, as to whether the electric current can be made safe. It was believed that the replies to the questions therein contained would be valuable reading, of interest as much to the general public as to the profession; and that from the mass of opinions thus collected together some useful hints might be culled.

In answer to the circular numerous replies were forthcoming, the most important of which we have epitomised in the following table. Some well known names appear. It will be seen from the answers given that, on the whole, the various

NAME OF EXPERT.	QUESTION I. Can overhead electric lines be rendered reliably safe at all times? If so, how?	QUESTION II. Is there any reliable and durable method of insulation for overhead electric light wires which will absolutely prevent leakage in wet weather?	QUESTION III. Is there any reliable method of laying electric light wires underground?	QUESTION IV. Would the existing dangers be entirely overcome by placing the wires underground?	QUESTION V. How, in your opinion, can the present danger to life and property be completely overcome?	QUESTION VI. What means should be adopted to prevent fire in case of derangement on electric circuits running into buildings?
Prof. Brackett, Princeton, N.J.	Yes. By proper insulation, and running the wires to prevent crossing. All a matter of expense.	If the companies will pay for it.	Yes. In suitable conduits, exercising skill in arrangement and insulation.	Not necessarily; unless with extreme care as above, danger will disappear when engineers and linesmen are properly trained.	In never departing from the precautions already indicated. Never resorting to temporary expedients.	Have no concealed conductors, and employ proper "safety plugs."
Edward Weston, Newark, N.J.	Yes; by limiting the tension and putting in good work.	No. There is none.	For low tension currents, yes.	No.	To life by limiting E.M.F. To property by best work.	Good workmanship and well placed cut-outs.
F. E. Pettingell, Boston, Mass.	Yes. High grade. Okonite.	Yes; okonite is the remedy.	Yes. P and B conduit. Okonite wire.	Okonite.	Okonite.	Okonite.
Eugene T. Lynch, jun., contractor, New York.	Yes.	Yes.	Electrically (for a short time), yes. Commercially, no.	No.	Fewer wires, better insulation.	...
Charles J. Kintner, New York.	Yes; by concentric conductors insulated from each other, outer shell earthed, and use of converters.	Yes.	Yes.	Yes. By the converter system and concentric conductors.	Same as 4th.	Same as 4th, and limiting E.M.F. to 30 or 50 volts.
P. B. Delany, New York.*	...	...	...	...	...	...
Benj. Rhodes, General Manager Electric Light Plant, Niagara Falls.	Yes; use good insulation.	Yes.	No.	No; made worse.	Use good insulation.	Same as 5th.
G. B. Prescott, jun., Accumulator Co., New York.	Yes.	Yes; if properly erected	No doubt many. The conditions are:—1st, Mechanical protection. 2nd, Insulation and isolation.	Not necessarily.	By proper construction, insulation and safety appliances.	Suitably protected automatic cut-outs and fuses.
I. Frank Morrison, Brush Co., Baltimore, M.D.	Yes.	Yes.	Yes. A conduit through which workmen can pass, and insulated wires on insulated supports.	Yes.	Do all work properly, and have frequent inspections.	Automatic cut-outs on outside of building.
M. D. Law, Brush Co., Philadelphia, P.A.	Yes.	No.	No.	No, danger would be increased.	By avoiding leaks on lines.	Arc light wires to be run on glass insulators. Test the lines every two hours on incandescent wires; put fuses at every change of size of wire. Interiors not to be wired for more than 50 volts. Automatic cut-out outside building.
W. H. Markland, Electrician to Pennsylvania Railway Co.	Not with high potentials.	Less leakage occurs from overhead wires at insulators on poles than from hanger - boards, cut-outs, &c., which should be better insulated.	Keep the high potential lines overhead and the low tension lines underground.	Danger would be increased.	Prevent accidental crossing of wires and rigid inspection.	...
E. R. Weeks, National Electric Light Association, Kansas City, Mo.	Yes; by best construction and maintenance.	Same as 1st answer.	Yes, by tunnelling.	No; they would not.	Same as 1st answer.	Same as 1st answer.

REMARKS.—* As an inventor of a system of insulation cannot well answer the questions. Does not believe in overhead wires for large cities, they can be safely carried underground.

NAME OF EXPERT.	QUESTION I. Can overhead electric lines be rendered reliably safe at all times? If so, how?	QUESTION II. Is there any reliable and durable method of insulation for overhead electric light wires which will absolutely prevent leakage in wet weather?	QUESTION III. Is there any reliable method of laying electric light wires underground?	QUESTION IV. Would the existing dangers be entirely overcome by placing the wires underground?	QUESTION V. How, in your opinion, can the present danger to life and property be completely overcome?	QUESTION VI. What means should be adopted to prevent fire in case of derangement on electric circuits running into buildings?
Harold P. Brown, New York.	Arc light currents can be made safe up to 2,000 volts by:—(*a*) Using separately excited dynamos. (*b*) Using detectors showing a 5 per cent. leakage. (*c*) Using a complete system of guard wires. Doubtful whether alternating currents can be made safe above ground in bad weather. A question of induction not insulation.	No.	Chicago system seems most promising. Does not believe in metal-covered wires for alternating currents at any rate.	Intensify danger from alternating currents.	See answer to 1st question. Limit alternating currents to 300 volts, and discharge all workmen who are careless in handling high potential wires.	By abolishing the grounding of any light circuits of more than 100 volts, and use of suitable fuses at both ends of all other circuits for electric service.
Elihu Thomson, Lynn, Mass.†	...	...	...	...	...	...
W. Hochhausen.	Yes; if enough is spent on the line.	...	Yes; if enough money is spent, and the wires should be insulated with as much care as a submarine cable, and every care taken to prevent injury during erection but pulling wires into underground ducts is not conducive to reliability.	...	...	...
S. S. Leonard, Minnesota Brush Electric Co., Minneapolis, Minn.	Yes; by good construction, daily inspection, keeping off of buildings, and testing with very strong currents for grounds and crosses.	Perhaps by care as to insulation, &c.	No experience.	Some would, but others would arise.	Don't believe it can be overcome entirely.	Safety fuses for incandescent light. Automatic cut out for arc lights outside of buildings.
Wm. Hochhausen, Excelsior Electric Company, New York.*	Yes; if properly insulated and maintained.	Rubber coating protected by strong waterproof covering.	An iron-clad submarine cable is reliable underground.	No; the present methods of doing so not reliable.	Removing all dead wires and frequent inspections.	Reliable cut-out exterior to building.
F. W. Jones, Postal Telegraph Cable Co.‡	...	...	...	...	...	...
Schuyler S. Wheeler, New York, Subway Co.	Yes; by first class insulation and construction.	Yes; by good gum insulation.	Yes; with lead-covered cables with plumber's wiped joints.	No.	No opinion.	Cut-outs and good wires.
Frank C. Mason, Police Department, Brooklyn, N.Y.	Yes; by best construction and maintenance.	Yes.	Yes.	Not entirely.	Good insulation and constant inspection. A gas main is unsafe if full of holes.	Automatic switches and fusible cut-outs.
Frank Upton, Newark, N.J.	Yes; by good construction and limit of tension.	No; there is no absolute preventive against leakage in wet weather.	Yes. For low tension currents.	No.	To life by limit of tension. To property by best workmanship.	Good workmanship and properly placed cut-outs.
Thos. D. Lockwood, American Bell Telephone Co., Boston, Mass.§	Generally; but contingencies will arise even with the greatest precaution.	Yes, several; and by almost hourly testing, and removal of defective wires.	Knowing what is to be done, it can be done.	No. Danger will always exist where *any* of the forces of nature are employed.	It cannot at all; but it can be cut down by good construction and maintenance.	A cut-out inside operated from the outside. Wires run on non-combustible bases and fuses with a receptacle to catch molten metal.

* To be added to former particulars.

REMARKS.

† Many of the accidents are due to gross carelessness, sometimes combined with ignorance. Some accidents are difficult to prevent, being in electric work akin to the suffocation caused by people blowing out the gas, while many are due to faulty installation and superintendence and are preventable.

‡ The whole question could be better settled by a board of electrical engineers, not in the pay of capitalists, to formulate rules somewhat similar to steam regulations.

§ The substance of the whole matter is, that if the business is properly run, few lamps on a circuit, and proper insulation used, the possible danger can be reduced to a very low point; but it may be costly to carry on a hazardous business safely.

experts have spoken in a fairly independent manner, and have not been biased to any great extent in favour of the systems to which they belong. There are two exceptions to this rule, one, of Mr. F. E. Pettingell, who evidently is gone on "okonite" and fancies that insulation to be a remedy against all evils and accidents attendant on the use of overhead lines, although he has not quite so much confidence in the material for underground cables. The other exception is that of Mr. Delany, who honestly says that as an inventor of a system of insulation himself he must be excused from answering the questions categorically.

Mr. Hochhausen incidentally mentions that the extensive use of underwriter's wire was not made by the free will of the electric light companies, but on the compulsion of the insurance offices who required the coating over the wires to be non-inflammable, and who had not, at that time, sufficient knowledge to be aware of the fact that although the material would not burn, yet it could absorb moisture after the fashion of a sponge, and, therefore, during wet weather would become worse than useless as an insulator. The underwriters were unaware, also, that water, not fire, is the prominent cause of trouble in electric light circuits.

DYNAMO-ELECTRIC MACHINES.

(*Concluded from page* 147.)

With a speed of 750 revs. per minute and a magnetic field of less intensity we arrive at a density of current of 3·65 in the induced convolution, the constants of the current being as follows: E.M.F. 56 volts, current 800 ampères for an average operation of 6 to 7 hours daily, when the first density corresponds to a continuous operation of longer duration, as, for instance, in connection with electrolysis of aluminium salts, of which Table III. gives the points as stated at various dates.

TABLE III.

Dates.	No. of days.	Hours in operation.	Hours at rest.	No. of volts.	Weight of the metal produced.
					kilos.
November, 1888	30	715	5	6	140
April, 1889 ...	30	715	5	6	160
July, April, 1889	36	858	6	6	288
Sept., Oct., 1889	42	1001	7	6	504

(*b.*) *The Intensity of the Magnetic Field*:—No useful comparison can be made between the machines by merely taking note to the density of the current which traverses them.

Their *coefficient of merit* depends upon other quantities, like their weight per unit of power, their mechanical yield, the price of the unit of material employed (iron and copper), their wear and tear, &c.

Nevertheless, the factors which enter into the calculation of the coefficient of merit may be reduced to two—the current's density, and the intensity of the magnetic field, if we only consider the strength per unit of electrical energy furnished by the unit of weight of the armature wires to a linear speed equal to the unit, the metre; we shall introduce in the representation of this coefficient a third factor, which is none other than the price of the total material employed in relation to the unit of useful work, the electric horse-power, when we desire to compare them from an economical standpoint.

Table IV. contains the values of the intensity of the magnetic fields, H, of the latest Edison, Breguet-Gramme and Desroziers, machines expressed in C.G.S units, the magnetic field being taken as distributed evenly over the periphery of the ring.

We likewise find in Table IV. the elements which enter into the calculation of this quantity

$$\text{H} = \frac{10{,}000\ \text{E}}{\text{L}\ \lambda}$$

E is the E.M.F. developed by the armature expressed in volts.

L the linear speed of the armature coils expressed in metres per second.

λ the length of the same wires traversed by the total current expressed in metres. 10,000 is a coefficient dependent upon the dimensions of the units of the terms H, E, L, λ.

The Edison, Breguet, and Desroziers machines present an intensity of field nearly equal to 2,600 units, supposing them to be evenly distributed over the periphery of the ring.

(*c.*) *Coefficients of Merit.*—We shall explain why it is that the first of these coefficients, A, that is to say, the one which has sole relation to the effective power developed by the unit of the induced coils, only depends upon the density of the current and the intensity of the field.

In the first place, from the nature merely of its definition, it is proportional to the work engendered by the unit of weight of the induced coils, the mechanical yield being taken as constant.

The effective electric power of a machine is given by the expression

$$\Psi = \frac{\varepsilon\ \text{I}}{9}\ \text{kilogrammetres.}$$

ε is nothing but the difference of potential at the terminals of the machine. The terms ε and I might be expressed in another form.

In the machines in question the electric yield of the armature is about 97 per cent, the mechanical yield about 90 per cent.

In the electric yield as shown by us, we do not take into account the expenditure in the field, since it represents merely the electric yield of the armature. If ε is the E.M.F. engendered by the ring, we may write

$$\varepsilon = 0{\cdot}97\ \text{E}$$

and by substituting for E its value drawn from the expression (I) of the magnetic field

$$\varepsilon = 0{\cdot}97 \times \propto \times \lambda \times \frac{\text{H}}{10{,}000}.$$

TABLE IV.—*Electric Results of some well-known Electric Machines and Intensity of the Magnetic Field.*

Name of machine.	Type and numbers.	Field magnets.				Armatures.										
		No. of convolutions, *n*.	Intensity, I.	*n* I	Resistance.	No. of convolutions, *n*.	Intensity, I.	*n* I.	Resistance.	Total effective length of the convolutions, λ.	Mean diameter of the effective convolutions.	Mean circumference of the convolutions.	Speed per minute.	Linear speed, L.	Electro-motive force.	Intensity of the field, H.
										Metres.	Metres.					
Edison......	1889	1320	17	22,400	3·50	28	600	16,800	0·002	17·2	0·357	1·12	670	12·5	56	2,610
Breguet ...	Manchester	4264	8	34,100	13·10	102	350	35,700	0·006	29·8	0·433	1·36	640	14·6	114	2,620
Desroziers	à plateau...	4032	19	76,600	6·25	132	680	89,800	0·005	29	1·37	4·30	300	21·5	154	2,470

If we write the intensity, I, in relation to the density of the current, δ, and of the section, S, of the armature wire, we have

$$\text{I} = \text{S}\,\delta$$

We get for the new form of effective electric power

$$\Psi = \frac{\text{H}}{10{,}000} \times \text{L} \times (\lambda \times \text{S}) \times \delta \times 0{\cdot}97\,;$$

but λ S is nothing but the volume, V, of the effective armature convolutions, which may be expressed in relation to the weight of these coils, P, and of the density of the copper, 8·95, when

$$\Psi = \frac{\text{H}}{10{,}000} \times \text{L} \times \frac{\text{P}}{8{\cdot}95} \times \delta \times 0{\cdot}97.$$

If we make, in accordance with the conditions laid down, L and P equal to the unit, we get at last for the effective power corresponding to the unit of weight of the effective coils :

$$\phi = \frac{0{\cdot}97}{8{\cdot}95 \times 10{,}000}\ \text{L}\,\delta$$

$$\phi = \frac{108}{10{,}000{,}000}\ \text{L}\,\delta$$

that is $\phi = \text{K L}\,\delta$

and for the coefficient of merit

$$\text{A} = \text{L}\,\delta.$$

A study of the various types of machines gave us the following :—

TABLE V.

Dates.	Machines.	Effective force developed.	Density in the armature.	Intensity of the magnetic field.	Coefficient of merit.
		Horse.			
July, 1889 ...	Desroziers	138	4·28	2,470	10,596
„ 1887 ...	Edison	44	2·90	2,610	7,569
Nov., 1881...	Gramme, A.	2·8	3·90	1,720	6,708
Jan. 7, 1889	Breguet	52·5	2·75	2,620	6,555
Nov. 1881 ...	Gramme	1·33	3·50	1,500	5,250

The constants of the current corresponding to the effective electric power developed are set down in Table IV.

The Desroziers machine presents the highest coefficient of merit, A.

Let us now see if the order of the machines is the same when we take into consideration the coefficient of merit, B, into which enter both the total weight of the material, P, employed for the unit of power, and the price, *f*, of the unit of material ; we do so under all reserve with reference to this last quantity, as it is liable to undergo variations independently of the arrangement of the machine.

We give, however, two forms of coefficients, B, for the first B_1, only the weight, P, of the material for the unit of effective power will be considered

$$\text{B}_1 = \text{H}\,\delta \times \frac{1}{\text{P}}.$$

For the second, B_2, we shall also take into account the price, *f*, of the unit of material

$$\text{B}_2 = \text{H}\,\delta \times \frac{1}{\text{P}} \times \frac{1}{f}.$$

TABLE VI.

Machines.	Weight in respect of the effective unit of power, P.	Price of the unit of material *f*.	Coefficients.		
			A	$\text{B}_1 = \frac{\text{A}}{\text{P}}$	$\text{B}_2 = \frac{\text{A}}{\text{P}f}$
	Kilos.	Francs.			
Desroziers	40	2	10,596	265	133
Edison	90	1·1	7,569	84	76
Gramme-Breguet	50	1·75	5,655	133	76

Table VI. contains the values of these coefficients calculated thus in respect of the most powerful machines.

The order remains very much the same for the three coefficients of merit, A, B_1, B_2. In order to obtain a definite conception of the intrinsic value of these machines, we have to take into account their wear and tear with time and their maintenance in operation, quantities which cannot be settled *à priori*, and which experience alone can determine.

A REVIEW OF 1889.

(*From the "Journal Télégraphique," of Berne.*)

THE year 1889 has been, from a telegraphic point of view, one of those periods of calm which generally precede a not far distant international telegraph convention.

In fact an assembly of this nature is likely to be held in Paris during 1890, and very probably in the month of May ; in view of this event telegraph administrations and companies have withheld, to a certain extent, from those active measures which lead to improvements in the service, and to the reduction of tariffs, steps which constitute the chief element of progress.

Notwithstanding this reserved attitude the general system of lines continues to be developed in a sufficiently noticeable manner, and we have shown, in our new edition of "cable nomenclature," that since 1887, the date of the previous appearance of this publication, the total length of the important submarine communications of the world has been increased by nearly 15,000 kilometres, of which about 6,000 were laid in 1889. These additions are nearly wholly due to the persevering work and enterprising spirit of the Eastern Telegraph Company, to whom international telegraphy owes a considerable portion of its progress.

An important episode in the annals of submarine telegraphy is the transfer to Government Administrations of the system of Channel cables, in consequence of the termination of the Submarine Telegraph Company's contract, and the purchase of the other cables in the same waters by the respective Governments. The result has been an increase to the German submarine system of 2,000 kilometres of cables, comprising 3,350 kilometres of conductors ; Belgium has acquired 100 kilometres of cables, with 514 kilometres of conductors ; the Danish system is increased by 127 kilometres of cables, with 195 kilometres of conductors ; France has an additional 133 kilometres of cables, with 896 kilometres of conductors ; and lastly, Great Britain has an increase of 1,133 kilometres of cables, with 4,713 kilometres of conductors.

At the same time we may mention that the Italian submârine cable system has, during the last two years, received an addition of 767 kilometres, and that the Dutch East Indian cables have been increased by 846 kilometres.

The three companies which disappeared in 1889, in consequence of the termination of concession and subsequent purchase by Governments, are the Submarine Telegraph Company, the Vereinigte deutsche Telegraphen-Gesellschaft, and the Hambourg-Helgôlander-Telegraphen-Gesellschaft ; these companies together owned 3,635 kilometres of cables, with 10,300 kilometres of conductors.

These changes have modified the positions of the Governments with regard to the importance of their respective submarine systems as stated by us in January, 1888. France still holds the first place as possessing the greatest length of cables, but Great Britain now exceeds her in length of conductors ; Germany, again, owns a longer length of cables than does Great Britain ; but she is subordinate to both France and Great Britain in length of conductors, as will be seen by the following figures :—

	Total length in kilometres.	
	Cables.	Conductors.
Great Britain	2,757	9,393
France	6,054	6,847
Germany	2,925	4,551

We will not revert to the many schemes contemplated or in progress for submarine cables, such as the direct cable between Europe and the Argentine Republic, the Pacific cable, which is to afford a new and independent route between Europe and Australia, &c. ; we will only mention that now, since both the Eastern and Western Coasts of Africa have been given a complete and circumscribing system of submarine cables, it seems that efforts should again be made for the connecting of the adjoining islands, and it is to be hoped that the question of giving telegraphic communication with Madagascar, Réunion, and Mauritius, will at last meet with the result so long awaited.

Among the extensions of important international land lines, it is necessary to mention the organising of direct communication between the Tonquin lines and the Chinese lines at three points on the frontier. The convention between the French Republic and the Chinese Empire marks an important progress.

The annual increase of traffic keeps at the normal rate of from 8 to 10 per cent., and appears to be divided in fairly equal proportions between the internal and international communications. The total number of telegrams received and sent in 1888 amounted to, in Great Britain, about 60 millions, 53 being on the internal service and 7 on international; in France 38 millions, 31½ internal and 7½ international; Germany 25 millions, 17 internal and 8 international.

Telegraph stations have during the year been augmented by about 2,000; and the total number in the entire telegraph system is more than 60,000.

So far as regards the telephone, improvements continue to be very observable; Germany, which stands at the head of great European States, by reason of the constant development of the telephone system, reckoned at the end of May, 1888, 176 systems, nearly 35,000 subscribers, and over 150 million telephone messages per year between the subscribers; that is to say, about 14 messages per day per subscriber.

In France, the systems belonging to the Société Générale des Téléphones were taken possession of by the State from the 1st September, and the Administration considerably reduced the price of subscriptions by fixing the annual tariff at 400 francs, instead of 600 francs, in Paris, and at 300 francs in those towns provided with an underground system, and at 200 francs in other towns, instead of 400 francs.

It is, however, in Switzerland that the greatest progress in this direction has been made, by the reduction of the annual subscription to 80 francs for the whole of the Swiss system; it would be indeed difficult to afford to the public the use of the telephone at more moderate terms. At the same time, the telephonic service has in this country been developed in a most remarkable manner. On December 31st, 1889, the number of Swiss systems amounted to 78, the number of subscribers to 9,203, and the length of telephone lines was 13,237 kilometres. The exceedingly liberal law recently passed by the Chambers fixing the annual subscription at 80 francs, and which came into force on January 1st, 1890, must prove a fresh stimulus towards the development of the telephone service by placing this useful method of communication within reach of every purse.

We cannot, in this brief notice of the year which has just terminated, review the many important additions to the advancement of electro-technical science in general; it must suffice us to mention the investigations of Prof. Oliver Lodge on atmospheric electricity and lightning conductors, and the surprising deductions arrived at more recently by Prof. Hertz, of Bonn, whose experiments prove that light is in reality only one of the many manifestations of electricity. We refer our readers to the articles written upon this interesting question by our learned contributor, Dr. Rothen.

We will conclude with a word or two upon the Universal Exhibition held at Paris in 1889, and in whose brilliant success electricity had some share. In fact, the electric light, and more particularly its application to the lighting of the fountains, attracted, without doubt, the largest number of spectators. Electric lighting upon such a large scale, and within a so limited compass, had never previously been witnessed. Engines of 4,000 horse-power, supplied by means of 200 kilometres of cable, no less than 1,500 arc lamps, and 10,000 incandescence lights. The total amount of light diffused throughout the various illuminated localities exceeded 200,000 carcel burners. We could easily continue at some length upon this interesting subject, but we have scarcely sufficient space in which to mention the innumerable applications of electricity in railway work, or the electric registers of the Eiffel Tower; with regard to the latter, any review of the period which made no mention of the illustrious engineer would be guilty of a regrettable omission.

We now come to the painful portion of this annual review; it is our sad duty to recall the names of those who have left us in 1889, and the list is a mournfully long one. At the commencement of the year the Administration of British Telegraphs lost its chief, Mr. Patey, third secretary of the Post Office, who died in the prime of life, only 45 years of age. We have had occasion to refer to the exceptional qualities possessed by this eminent administrator, and we again sympathise with the sorrow this unexpected death has caused. But another loss touches us more nearly; the death of M. Curchod, the veteran of telegraph assemblies, for 20 years the director of this journal, and the founder of the Bureau International, will be regretted by all who came in contact with him, equally in public as in private life.

Among scientists and engineers connected with electrical pursuits, and more especially with the telegraph, who have passed away during 1889, England appears to have rendered the heaviest tribute; Mr. J. W. Fuller, who died in London in April, Sir Daniel Gooch in October, and Mr. J. Kaye Gray more recently in Mentone, were chiefly connected with submarine cables. Among the celebrated electricians who have contributed in a notable manner to the progress of electro-technical science, were Mr. Warren de la Rue, who died in London in July, and Dr. James Prescott Joule at Manchester in October. The world of electrical science has, in France, lost the able services of M. Gaston Planté, who died at Paris in the month of May, and whose name will be handed down in connection with many important discoveries in electrical science.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 119.)

VII.—PARASITIC CURRENTS—(*continued*).

THE space for the winding inside the ring is considerably less than that on the outside, and accordingly, if the wires on the outside are close together, inside every third or fourth one, as the case may be, has to ride above the others, forming a broken layer on the top of a complete one. A wire has to be dropped at regular intervals to form the riders, and if the conductors consist of two rather large wires in parallel, say ·238 inch diameter, it is worth while improving the winding in fig. 141, by dropping the wires so that the two constituting the conductor are crossed and occupy reversed positions on the first and second convolutions. Fig. 142 shows two sections of an armature wound in this way. A and B are the two wires constituting the conductor, A_1, B_1, being joined together at the commencement of the section. B is wound straight, A rides so that on the second convolution at A_2, B_2, the wires, A and B, have their positions reversed, the ends

A_3, B_3, inside being connected to the commutator. In the second section the same condition is observed, the wires, C and D, having reversed positions in the first convolution, C_1, D_1, and second convolution, C_2, D_2, the ends, C_3, D_3, being connected to the commutator.

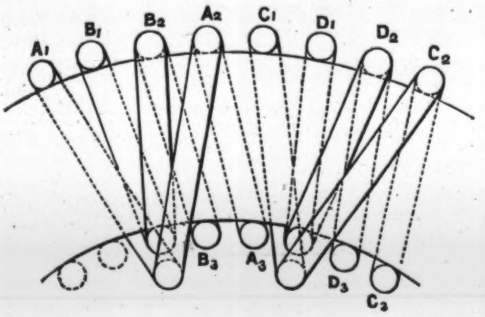

FIG. 142.

It will be seen that this winding gives for two convolutions per section the same result as was obtained by the device employed in fig. 139C. In the latter we had one convolution per section, and a conductor divided and crossed in the middle, so that its divisions occupied different positions in each half of the length, while in the case now under consideration, we have two convolutions per section, and the divisions of the conductor crossed over so that they occupy different positions in the two convolutions. Resulting from variation in the lines of force enclosed between the two divisions, the resultant E.M.Fs. will be in the same direction in each convolution; if in the first, for instance, it is from the reader down A_1 in the second, it will be from the reader down B_2, A_1, B_1, being connected together at one commutator bar, and A_3, B_3 at another, it will be seen that A_1, A_2, A_3, B_3, B_2, B_1, form one continuous coil, and as the two E.M.Fs generated in the lengths, A_1 and A_2, oppose each other, the resultant E.M.F. is therefore *nil*. In the figure one out of every four inside wires is a rider, but it will be understood that every second or every third may ride according to the ratio of the central opening to the outside diameter of the core. In the actual winding the wires are, of course, close together.

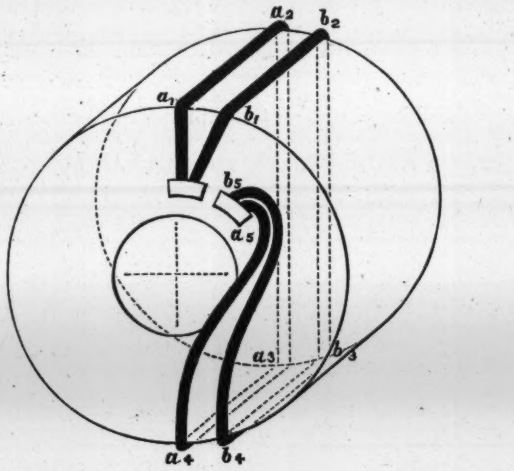

FIG. 143.

In winding drum armatures similar precautions must be adopted to prevent the generation of parasitic currents. Fig. 143 represents one convolution of a drum winding, the conductor being constituted by two wires, *a* and *b* in parallel. These wires are necessarily connected together at the commutator plates where the section begins and ends, but in connecting to the conductor opposite, which forms the other part of the convolution, the two wires, *a* and *b*, may be connected together or kept apart at pleasure. If end discs are employed to connect opposite conductors as in the old Edison machines the two parallel wires are connected at a_2, b_2, and a_3, b_3, parasitic currents being therefore free to flow in each of the opposite parts of the convolution just as they were in the split bar, fig. 139B. Connected in this manner the two bars would have to be crossed in the middle of their length, as in fig. 139C. But suppose the parallel wires are kept apart, as shown diagrammatically in fig. 143, two cross pieces insulated from each other taking the place of the disc. Under these circumstances the algebraic sum of the lines of force between the two divisions, considering a_1, a_2, a_3, a_4, a_5, b_5, b_4, b_3, b_2, b_1, as a continuous coil, is almost *nought* for every position, since between the divisions of the conductor on one part of the circumference are enclosed as many lines from a N pole as there are enclosed lines from a S pole between the divisions diametrically opposite. If the conductors are diametrically opposite, the resultant is exactly nought and the parasitic currents therefore *nil*, this being the case when the two sections connected to opposite commutator plates are wound one above the other. When these sections are wound side by side however, the resultant has for some positions a small value though for others it is nought, and theoretically there is a small loss from parasitic currents. But it is so small in most instances that it may be quite neglected.

It is apparent, then, that armatures may have a drum winding with conductors, the angular width of which could not in a cylinder winding be permitted. But if parasitic currents are to be eliminated, the parallel wires constituting the conductor must be kept quite apart from each other at the crossings, and connected only at the commutator plates or at the radial strips leading thereto. Though the conductor shown in the figure has only two parallel wires it will be understood that it may consist of a band of half-a-dozen wires, or more, lying side by side. These wires must not be crossed over each other, and must be in contact only where they join the commutator plates, as already stated.

The winding of drums with small wires can be very well carried out according to the method above described, but where large currents have to be carried it is more convenient to employ bars instead of a number of wires, those opposite each other which form the convolution being connected by spiral strips. With a bar winding it would be exceedingly inconvenient to divide each conductor into several separate pieces, and connect across by as many spiral strips separated from each other, hence the bars must be constituted so as to permit of single cross connections. In this case we have to deal with a length of conductor, the separate parts of which are connected at one end to the commutator plate, a_1 b_1, fig. 143, and at the other end, a_2 b_2, to the spiral crossing piece. It has been stated that if the bar is divided and the two halves crossed, as in fig. 139C, the parasitic currents are to a great extent reduced, but there is still a considerable angular width and a considerable mass of metal in each half of the bar, which means that the device, although reducing the loss, does not entirely prevent it. If for the bar conductor split in two we employ a stranded cable, with the strands insulated from each other, we have the same E.M.F. generated in each wire the strand, the resultant is *nil*, and, consequently, of there are no parasitic currents. It is only when in the separate components of the conductor the E.M.F. generated is not quite equal that parasitic currents flow, due to the difference, and all the devices for eliminating such currents have consisted in arranging matters so that in each component the same E.M.F. is generated. In fig. 139C, for example, the crossing of the two parts of the bar makes the E.M.F. generated in each half similar, while in the two halves of the bar in fig. 139B, where there is no crossing there is a difference, and resulting from it a current, as indicated by the arrows. In fig. 142, the sum of the E.M.Fs. in A_1 and A_2, which form one component, are supposed to be equal to those in B_1 and B_2, hence no local current flows. Again, in fig. 143, though the E.M.Fs. in the two parts of the conductor lying on the top of the armature may be different, taking the whole of the convolution, the E.M.Fs. in both components are similar. Lastly, in the stranded conductor the E.M.F. is the same in each component. The insulation of the separate strands may be effected by running them through an insulating varnish while stranding, or, better still, by giving them each a single covering of fine cotton first. It is questionable whether the oxidation of the copper forms a sufficiently good insulation, though some rely upon this alone. After stranding, the cable can be shaped to a square section, in order that the space for the winding may be economised. The conductor so formed can be used for both cylinder and drum windings.

It is well known that by sinking the conductors into slots in the circumference of the armature, parasitic currents may be eliminated; the lines of force, under these circumstances, passing into the armature between the slots without passing through the conductor itself. With slotted armatures solid conductors may be therefore used without waste of power.

Although we have spoken of parasitic currents as if, when the proper precautions are not taken, they could flow in opposite directions along adjacent components of a conductor, it will be understood that this can only be the case when the machine is running separately excited, and with the armature circuit open. When the conductors are carrying their full load, the tendency to create such currents is, of course, still present, but it is manifested then in an unequal distribution of the current in the conductors.

(*To be continued.*)

ON THE DISTRIBUTION OF THE CURRENT IN CONDUCTORS OF THREE DIMENSIONS.*

By M. P. JOUBIN.

MAXWELL applies to the distribution of the electric flow in a conductor of three dimensions the same principles as in electrostatics—the principle of Thomson's images, for example. I had proposed to verify experimentally that, given a flow of electricity $+ m$ per unit of time, emanating from a point, A, of a conducting medium in contact with a second medium on an indefinite plane, P, we might replace the plane for all the points of the first medium by a flow $\frac{K_2 - K_1}{K_2 + K_1}$, m emanating from a point, A_1, symmetrical with reference to A; K_1 and K_2 being the specific resistances of the two media; if $\frac{K_2}{K_1}$ is very small, the flow becomes perceptibly $- m$. From this we infer that the flow which passes through an element, d S, of the plane, P, is proportional to the angle under which it is seen from point, A, or calling ρ the distance from A to d S, in inverse ratio of ρ^3.

Point A is a Wollaston electrode connected to the positive pole of a battery. The plane, P, is composed of two circular sheets of copper 22 cm. in diameter, each divided radially by an opening 1 cm. in width, the two openings being superposed. A sheet of platinum placed between them restores the continuity of the plane. Lastly, the two plates are tightly fastened together by means of a clamping screw, and placed at the bottom of a vase of similar diameter upon a layer of mercury in communication with the other pole of the battery. Between these two electrodes we electrolyse a solution of sulphate of copper.

The experiment concluded, we introduced the sheet of platinum and analyse the deposit by dissolving it, centimetre by centimetre, in nitric acid. We got in this way the average quantity of copper per unit of surface, that is to say, a bulk proportional to the flow, for the abscissæ of 1 cm. and upwards from the centre in the direction of the radius. By means of elementary rectangles representing the weight of the copper, we are enabled to delineate a curve. Let a be the normal distance, A P = 4 cm., and x the abscissa of the point where the density is σ; this curve should be represented by an equation in the form of $\sigma = \frac{A}{(a^2 + x^2)^{\frac{3}{2}}}$, and the integral by $\int \sigma \, d \, x = \frac{A}{a^2} \frac{x}{(a^2 + x^2)^{\frac{1}{2}}}$ between the limits 0—1, 1—2 .., to represent the weights found by experiment. Note here that a being known, only one constant, A, enters into the formula. Here we have the results of the comparison with the curve

$$\sigma = \frac{5{,}230}{(16 + x^2)^{\frac{3}{2}}}:$$

x.	$\int \sigma \, d u$. mgr.	Experiments.
0—1	79	77
1—2	68	70
2—3	50	50
3—4	36	39
4—5	23	22·5
5—6	17	15
6—7	12	11·5
7—8	9	9
8—9	6	7·5
9—10	5·5	6·5
10—11	4	4·5

These numbers are very concordant. We observe that the total weight deposited was 317·5 mgrs.; the integral $\int_0^\infty \sigma \, d x = 327$ mgrs. only differs from it by 0·06. The conducting plane may therefore be looked upon as indefinite. The 10 mgrs. loss were deposited upon the mercury and a little under the platinum; the adhesion of which was not complete. We observe, moreover, some slight irregularities upon the edges.

From the above very simple example we may conclude that the extension of the images principle to dynamic electricity is legitimate; that the surfaces of the flow and equipotentials are the same as in electrostatics.

ON THE RELATION BETWEEN THE ELECTRIC AND THERMIC CONDUCTIVITY OF METALS.

By M. ALPHONSE BERGET.

IN a former communication I had the honour to lay before the Academy (*Comptes Rendus*) a simple method which, while, realising the theoretical case of the Fourier wall, allowed of the measurement by means of simple determinations of temperature of the thermic conductivity of different metals in comparison with that of mercury. Having already measured this latter as a positive value, the result was that the method gave me the positive conductivities of the metals in question.

I have since applied these determinations to various metals which were not included in my previous experiment, and having by this means obtained reliable positive measurements of their thermic conductivity, it occurred to me that it would be interesting to compare the values of their electric conductivities obtained upon similar principles, this being a condition essential to the comparison.

For this purpose I removed from its protecting ring the cap which had been placed there as the measure of thermic conductivity, and determined the electric conductivity by Sir Wm. Thomson's method of the double bridge. I then endeavoured to find out the relation of the mean coefficients, k, of thermic conductivity to the mean coefficients, c, of electric conductivity measured as regards both between 0° and 30°. The results are set out as follows :—

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* *Comptes Rendus.*

Metals.	k.	c.	$\frac{k}{c}$
Copper	1·0405	$65·13 \times 10^{-5}$	$1·6 \times 10^3$
Zinc	0·303	$18·00 \times 10^{-5}$	$1·7 \times 10^3$
Brass	0·2625	$15·47 \times 10^{-3}$	$1·7 \times 10^3$
Iron	0·1587	$9·41 \times 10^{-5}$	$1·7 \times 10^3$
Tin	0·151	$8·33 \times 10^{-5}$	$1·8 \times 10^3$
Lead	0·0810	$5·06 \times 10^{-6}$	$1·6 \times 10^3$
Antimony	0·042	$2·47 \times 10^{-5}$	$1·7 \times 10^3$
Mercury	0·0201	$1·06 \times 10^{-5}$	$1·8 \times 10^3$

We observe that the order of conductivity is the same for heat and electricity, but that the relation $\frac{k}{c}$ is not strictly constant, I do not believe, therefore, in absolute proportionality between the coefficients of electric and thermic conductivity.

I had examined on a previous occasion the variation of the coefficient of thermic conductivity of mercury between 0° and 300°. I then found the mean coefficient of variation to be 0·00046 for 1°, or different from the corresponding coefficient of variation of the electric conductivity which is 0·00085.

The rule as to the proportionality of two conductivities is therefore only approximately exact, being almost in the condition of that of Dulong and Petit relating to specific heats.

EXPERIENCE AS A TEACHER IN ELECTRICAL ENGINEERING.*

By FOREE BAIN.

"A THOUSAND volumes in a thousand tongues, enshrine the lesson of experience ; yet a man shall read them all and go forth none the wiser." The experience of a man may be considered as a book of which each day forms a page and the finale of life completes the volume. It is a book that cannot be truly translated into any language sufficiently expressive to impart to the reader the full text, force and meaning of its contents.

The five known senses which man possesses appeal to his reasoning faculties. In the operation of gleaning information from a book, the sense of seeing only is called into use, while the experience of many persons has contributed to the accumulation of the knowledge, enunciations of the problems, and to the expression of the thoughts contained therein.

Our environments are so crowded with mysteries, that it is hardly safe to say that we can express a thought that will convey the exact meaning intended. The capacity, the experience and the conditions of the individual must be considered ; the impressions vary as the conditions of the individual vary. At one time the meaning will be as clear as the dawn of a summer morn, while at another time words seem expressionless.

There goes with experience an impression of reality unattainable by other means, the demonstration of a thought satisfies the mind that the thing is not only a logical conclusion, but an objective entity. It is suggested by some that the mind of man is gradually approaching such a degree of perfection that eventually all facts may be arrived at by a system of logical reasoning, and indeed some of the ancient philosophers believed that they could solve all of the problems in the universe by thought alone, but the modern philosopher realises that meditation is futile unless accompanied by observation and experiment ; in fact the rise in modern science is due to the adoption of the principle that the discovery of a physical truth consists, not in the mere logical statement, but in its experimental establishment. The discoverer of a truth is not he who guesses, though he may guess aright, but he who practically demonstrates a new fact, and thus compels its acceptance within the body of knowledge. Theories can be made to fit facts, but facts are inflexible. Facts form the wall around the fortress of knowledge, against which the arrows of theories and false conclusions fall harmless. There may be several theories to explain a single fact, but the fact remains unattained. The fact is the exponent of the discoverer's thought, the index to the operation of his mind. By observing known phenomena he has been able to extract practically from nature new phenomena ; hypothetical reasonings, upon which a theory leading up to that result may be formed, are themselves valuable and instructive, but the practical demonstration is the true and greatest value of the investigation.

A book impresses the mind like the portrait of a friend ; the finished picture is before you, the outlines of a reality are spread upon the canvas, every feature has been faithfully portrayed, the visage of the friend is recognised at a glance, the artist's work is complete ; but you cannot follow the various processes of nature nor the surroundings which have gradually developed the characteristic features of his subject ; he can only present a picture of the work that has been previously done.

Books are the pictures of many minds, and like friends in need, they are friends indeed. While they cannot impart to us all that is necessary to enable us fully to comprehend and understand some of the complex problems of life, they are as faithful guide boards in the path of knowledge, and point toward the direction of progress and success, without which we would wander unceasingly in the wilderness of mystery and ignorance.

The progress due to the activity of investigation and invention in the science of electricity and magnetism, within the last few years has fostered, encouraged and developed the need of a new profession in the field of industrial pursuits. The electrical engineer of to-day finds himself as firmly established, and the demand for his services, by the public, to be as enduring and of as high a character as that of the civil or mechanical engineer. What the future may have in store for him is not within the province of this paper.

I shall endeavour to address myself to the young men who are young in the study of electrical engineering, and furnish a few practical illustrations which may be a means of impressing upon them the necessity of an individuality in method, and read a few leaves torn from the book of experience, of an electrical engineer. We find that certain things must be done which are unusual ; we search our text books, we cannot find a precedent, they are one and all silent on this particular subject, or if they mention it at all it is in such a vague and indifferent way that the information, such as it is, is of little value.

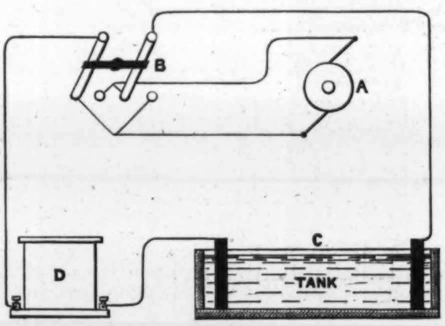

FIG. 1

The first illustration of my method of solving some such problems is shown by fig. 1, and it has proven very satisfactory. The arrangement shows a method of measuring the difference of potential between the terminals of a generator of high E.M.F. This can be done using only a small ammeter, and without the use of a voltmeter of any kind, and the results will be almost perfectly correct, near enough, at least, for all practical purposes. A is a dynamo, + and − terminals, B, a double pole switch, C, a tank of pure water, D, an ammeter reading from 1 to 10 ampères.

The tub is connected in circuit as shown, with two carbon electrodes, the resistance between the electrodes is measured in the usual manner before the current from the dynamo is passed through. Suppose that we know beforehand the approximate E.M.F. of the dynamo—say 3,000 volts—then, if our tub and circuit measure 1,500 ohms, two ampères will be indicated by the ammeter, C x R = E. The double pole switch is intended for two purposes : first, the reading should be taken as soon as the ammeter comes to a rest, and when it reaches the highest point, the circuit should be reversed by means of the switch, and the readings taken again when the ammeter reaches the highest point ; the second reading is only necessary as a check on the first. The object is to eliminate any error that might result from electrolytic or osmotic effect. The switch also makes it possible to cut the entire apparatus immediately from the live circuit as soon as the readings are taken. By using a hot wire ammeter the method can be used for alternating currents, in which case it will not be necessary to use a switch to reverse the poles.

Fig. 2 represents what I have found to be the most convenient and most easily adjustable method for connecting a plating or electrotyping dynamo and tank. The E.M.F. necessary in this work is very low, and the current strength is great, so that when an ordinary wire rheostat in the field circuit is used for varying the E.M.F. as usual, the steps for adjustment are too great, rendering it impossible to obtain the exact E.M.F. desired. As the contacts heat, the current going through the field quickly and greatly decreases, causing the voltage to fall rapidly. Moving the arm of the resistance box to the next segment, while it would temporarily correct the trouble, would finally intensify it by the increased heat of the contacts. Often the variation of one volt, or a fraction of a volt, from that required in galvanoplastic manipulation will so seriously interfere with the process of deposition as to cause entire failure. If the E.M.F. be too great, the deposits will be granular and rough or burned; if too low, the deposits will be slow and uneven. All modern dynamos designed for deposition are shunt or compound wound; the latter are liable to reverse, and the former are not always successful, for the reasons just related.

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* Read before the Chicago Electric Club, January 20th, 1889.

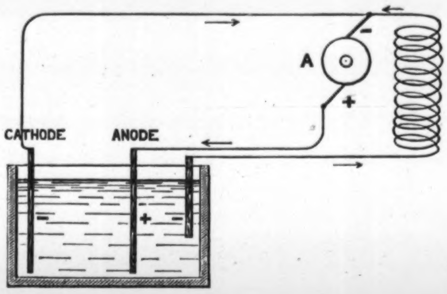

FIG. 2.

The cut shows an ordinary shunt dynamo, the + brush connected to the anodes and the − brush connected to the cathodes in the usual way. One terminal of the field is connected to the − brush; the remaining terminal is connected to a small adjustable cathode, in the same tank. This small cathode may be placed near any of the anodes, and may be so arranged that it can be conveniently moved toward or from the anode elements, thus decreasing or increasing the resistance of the field circuit. It will be understood at once that by varying this distance the ampère-turns of the field are consequently raised and lowered, and thus the E.M.F. may be minutely and permanently adjusted. All contacts may be soldered, and the resistance will remain practically constant.

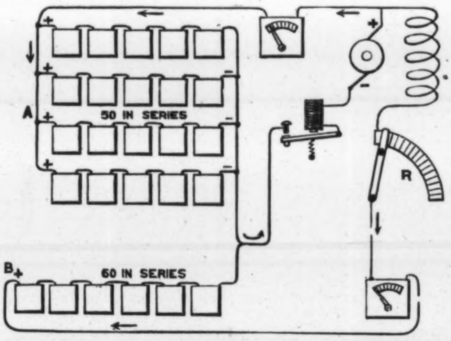

FIG. 3.

A very successful method of charging accumulators or storage batteries is shown in fig. 3. Without mentioning the objections to the use of series and shunt wound dynamos, I will describe this method in forming and afterward charging accumulators. The thing desired is a process by which a maximum current will flow at the beginning of the charge, or forming process, and will automatically and gradually decrease in strength as the process proceeds, until a point is reached when the current must be discontinued altogether. It is a matter of great convenience if this process can be accomplished automatically, as the work would be far better performed than if an ignorant and careless attendant was in charge. In this case the dynamo must be especially constructed for the purpose. Suppose, for illustration, we desire to charge 300 accumulators, arranged, as shown, to 2·10 volts each. Our dynamo must have a difference of potential of a little over 105 volts at the terminals, or the potential necessary to charge, say, 50 accumulators in series. Connect the accumulators, in the first place, in two groups, 50 in series in branch A, and as many in multiple to this group as desired, as shown; and connect a lesser number in branch B, say 52 or less, and connect the two groups thus formed in series, one group being electrically opposed to the other. At the point where the two terminals are joined connect the − terminal of the dynamo through an automatic circuit-breaker, having an adjustable retractile spring or weight. Connect the + terminal of one group to the + terminal of the dynamo. The + terminals of the other group must be connected to the + terminal of the dynamo through the field, and preferably a water and acid adjustable rheostat. Now, adjust the rheostat so that no current will flow in either branch and start your dynamo. Close the circuit at the cut-out, and the dynamo current should divide through the two circuits in the direction as shown by the arrows. The current will gradually decrease as the E.M.F. of the battery increases, and when the batteries have been charged to the desired point the cut-out will disconnect the − terminal of the dynamo, and, as the batteries are balanced, no current will flow through the circuit. Several series of batteries may be connected in parallel with the batteries in branch A, limited only by the capacity of the dynamo. The current of the dynamo will be always proportional to the sum of the resistance and counter-electromotive force of the groups. By this method a defective cell will be quickly detected by the diversion of current in the two branches.

In the spring of 1878, or 1879, I put up a telephone line for a gentleman in a little town in Ohio, between his residence and a large sawmill, about five miles down the river. A telephone was a question of doubt at that time, and naturally the event was anticipated with considerable curiosity and pleasure by all the town folks. The line was completed, and the instrument was properly connected at the residence, a number of people assembled to hear the "machine talk." In company with a boy, who could make a noise with a mouth organ, I set out with the other set of instruments for the mill. I got them connected all right, and awaited a reply to my lusty "Hello!" All was silent. I soon discovered that the diaphragm of my receiver was missing. What could I do? To return to the town without demonstrating the success of the apparatus, that night, would have been as disgusting to the eager and expectant persons as to myself. A sawmill is a desolate place, and the only thing that I could find in the shape of a diaphragm was a circular saw, and it was a trifle too large. I found a piece of writing paper, cut two diaphragms of this, got an old file and managed to file some bits from the head of a nail, placed these iron filings between the two paper diaphragms, removed the cap of the receiver and placed them in position, when, presto, my instrument worked to perfection. I merely mention this to show that many problems may be easily solved by the application of a few moments of independent and original thought. The text-books do not mention the use of a paper diaphragm, to be substituted in cases of this kind, for one "capable of magnetic induction," to use a familiar quotation. No particular ability is shown by this substitution for the usual form of diaphragm, for surely it was simple enough. My object in mentioning the instance was to illustrate the fact that experience naturally leads us in paths of practical expedients, and there will be many times when we may come in on "three wheels," so to speak, if, first, we understand our subject well; and, second, if we are not afraid to think of it in our own way and apply such remedies as will be suggested by mature thought and reflection.

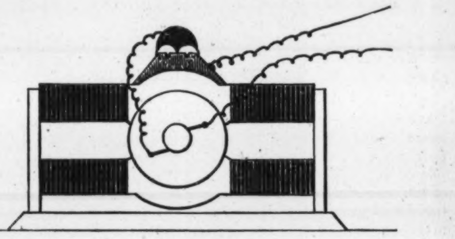

FIG. 4.

It may be interesting to illustrate a few more problems which have been solved in a practical way. Fig. 4 shows how a repaired armature may be tested. I frequently have armatures only to repair. Sometimes one or more new coils are to be wound in. It is necessary to make a test to see that there are no short circuits. The insulation resistance between the coils may measure up to the required standard, and there may be no "grounds" on the core, but the only way a test can be made for short circuits is by actually running the armature as a motor or generator. Mount the armature between centres or on frictionless bearings, and move it up by the side of the energised field of a dynamo and pass a current from the dynamo or other source through the armature. The armature will begin to revolve immediately. It will require only a few moments to discover a short-circuited coil, if one exists, by the overheating of such coil or coils. It may then be corrected and tried again. When an armature has stood this test I am ready to guarantee it. Did you ever know a short-circuit or burn-out to occur in a Siemens armature, except in the lower coils? One would think that when this is so it would be necessary to entirely rewind it, but such is not the case; take the bands off, and, with a sharp chisel, cut the injured coils in two and pull the ends out, fill up the space on the ends of the armatures where the old coil came out with shellac and cotton, and wind new coils on the outside, connect up and test, and there you are. I have repaired armatures in this way that have run for years afterwards.

Several years ago, I think it was when the first towers were being used from which to suspend arc lamps, I was consulted by the superintendent of such a plant, who complained that the carbons of his lamps would not remain in line during the day. The wind would jar them, so that they would slip by each other. When the dynamo was started at night they, of course, would not light up, but those that did light were not affected by the wind while they were in operation. This little problem was solved in the most satisfactory manner. I made several paper cylinders about 1½ inches long and a little tapering, and placed them between the upper and lower carbons on the lamps, fitting them tightly on the upper carbon, but loosely on the lower one. These paper stalls were put on the carbons by the trimmer in the morning, and they would hold the carbons in place against the strongest wind. When the lamps were started in the evening the paper stalls would immediately burn off, and the lamp mechanism would then hold the carbons in place. These stalls, or cylinders, were made of any kind of thin paper by the trimmer or engineer at night, and did not cost anything but time to make them.

In 1869, while a telegrapher in a little country town, it occurred to me that I could make a self-closing telegraph key, that would cause my name to go rumbling down the corridors of fame for an indefinite period. I conceived the idea of a pedal attachment to the key, so arranged that a slight pressure of the foot would open the circuit and a counteracting spring would close it. The idea was well worked out, and I was getting ready to spring it on an unsuspecting public, when unfortunately my favourite dog sprung it for me. The space under the table was a favourite resort of his, especially when he became sleepy. One day when I was engaged elsewhere he laid down for several hours on my pedal attachment, and kept the line open. The superintendent "located" him, and of course the result was heartrending; in this case, experience proved to be a teacher, for I have not made another pedal attachment since then.

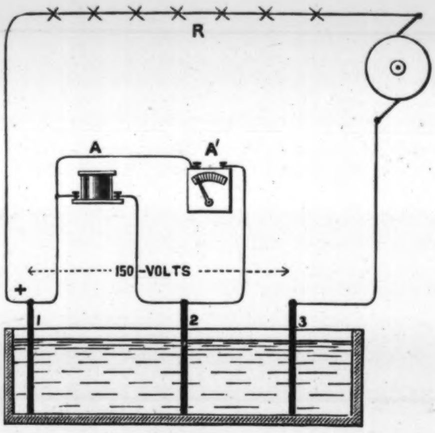

FIG. 5.

Fig. 5 shows a very convenient arrangement for comparing voltmeters, or means by which a voltmeter or ammeter may be calibrated by comparison with one known to be correct. In this case a constant current dynamo—say, 10 ampères—is shown. Several lamps are in circuit at R. A tub with three electrodes, 1, 2, and 3, are shown. The resistance between 1 and 3 is 15 ohms, hence 150 volts between 1 and 3. The movable electrode, 2, is connected with 1 through two voltmeters in multiple. The terminal, 2, may be moved from 1 toward 3, and any desired voltage in the most minute fractions may be indicated by the instruments. The unknown may thus be calibrated by the known. Ammeters may be calibrated or compared by this means, but of course must be in series instead of multiple with each other.

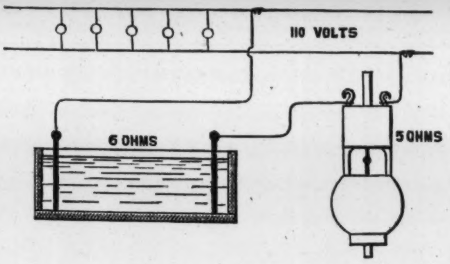

FIG. 6.

Fig. 6 shows a similar device for operating an arc lamp on an incandescent circuit. Any good arc lamp may be placed in a circuit of 110 volts by placing a tub of water and acid in series with it; the electrodes should be carbon, and the evaporation should be looked after.

There are no practical units of magnetism, and consequently there are no instruments to measure it directly. In the absence of such I have found that a very useful magnetometer may be devised, which will at least approximately show the relative strengths of electro or permanent magnets. An Ayrton and Perry voltmeter or ammeter, when placed in a magnetic field so that the lines of force are parallel with the length of its core will draw the core into the solenoid, the needle will indicate a certain number on the dial. Now place the instrument in a similar position in the field of another magnet and the deflection of the needle will be greater or less according to the comparative strength of the second magnet. This is very handy for quickly determining the fault of an unequal or distorted field in a dynamo or motor, and is close enough to enable you to repair such a fault and to learn when it has been corrected. I have seen "consequent pole" dynamos with a badly distorted field in which the distortion was caused by a greater number of ampère-turns on one limb of the magnet than on another, or by unequal magnetic permeability of the iron of which the field is composed, or an inequality of cross-section.

For fear that I may weary you with too long a paper I will close with a few words of advice to the young men who wish to succeed. The ladder of ambition is interminable in length, it extends upward from the densest ignorance of life and is shrouded with a mantle of mystery at the highest pinnacle of knowledge. There are a greater number at its base than have reached the giddy heights of success, there is more room as we ascend. If we have begun to climb, and our position makes it possible, we should not "look down" on those below. They may pass us some day and tread on our fingers. If we try to climb too many ladders we may find at the end of life that we have not reached a very high point on any of them and we will never get above the crowded position. Stick to one ladder and get as high on it as possible. The journey is a pleasant one if you will only contribute your share to the pleasure of others and be guided by the words of the immortal Pope:—

> "One science only will one genius fit,
> So vast is art, so narrow human wit."

TELEGRAPHISTS' GRIEVANCES.

A CROWDED and enthusiastic meeting of telegraphists of both sexes was held in the Foresters' Hall, Clerkenwell, to protest against the treatment recently meted out to certain telegraphists of the Cardiff office. Sir E. J. Reed, K.C.M.G., M.P. for Cardiff, supported by Mr. Pritchard Morgan, M.P. for Merthyr, occupied the chair.

The CHAIRMAN, who was received with great cheering, said the reason why he presided on that occasion was simply that, having been for many years in the Civil Service of the country, he knew how desirable it was for the *employés* of all the great public departments to hang together. He hoped no one would imagine, even for a moment, that there was anything political in the present occasion. No one could accuse him of any want of consideration for the Postmaster-General in any letters he had written to the latter on this subject; but it appeared to him, from the Postmaster-General's letters in reply, that a great deal of misconception existed about the matter. That misconception had not been, as the Postmaster-General seemed himself to admit, on the part of the men. He (the speaker) thought the position of these gentlemen deserving of all sympathy. He did not believe that the Postmaster-General, when he wrote his first letter to him, was aware that his surveyor had had authority from him, in any way, to visit any punishment whatever on those gentlemen. However, it was now quite well known to the Postmaster-General that transfers of men, very active men, and all of them of very considerable service, had been ordered, not only on account of certain presumed transactions with the Press, but as the penalty for their not having been able or willing to find out who it was had communicated with the Press. They had, in fact, been called upon to act the part of spies, which odious office had been imposed upon them by a surveyor without any instructions from the Postmaster-General. They had done wisely and properly. The Postmaster-General in his last letter to the speaker had stated, and stated truly, that the discipline in the Cardiff telegraph office was very lax. But why was that? He had been assured by a high postal authority, long before the present trouble arose, that in the whole of the United Kingdom there had been no parallel to the rapid development of the telegraph system in the town of Cardiff, and yet, notwithstanding that, they had a staff there which was overworked, and which had had no postmaster to supervise it for many months. The postal authorities and not the *employés* were the guilty parties. The latter had only availed themselves of such means as were open to them for ventilating their grievances. There was another statement of the Postmaster-General, which he trusted the latter would be able to justify—that on certain occasions the secresy of telegrams had been violated. If that was so, it was the duty of the authorities to discover and to punish the guilty parties, and not to inflict penalties upon innocent persons merely because they themselves were too indolent or too incapable to find out the guilty ones. The Postmaster-General's letter, published on Monday morning, had given him (Sir E. Reed) to understand that the removal of those gentlemen had been postponed; but in the subsequent letter he had been very sorry to find that all the Postmaster-General had seen his way to do was to give them leave of absence from their posts. The Postmaster-General said he had been misinterpreted. The mistake had not been made by the men, because they were the victims of it. Apparently the person who made the error was the surveyor. It was alleged that the *employés* in question had "failed to win the confidence of their official superiors." How? By refusing to act the part of spies. That was the offence. He hoped they would appreciate the difficulty in which Mr. Raikes had been placed by the indiscretion of his subordinate. He (the speaker) had seen some of the telegraphists and discussed the facts, and he believed them to be as innocent as those young ladies in the hall. He was very sorry not to be able to advise them to drop this agitation, but he asked them not to underrate the difficulty of attempting to coerce a minister. There were very few things from which ministers would shrink in support of one another against their *employes*.

The first resolution was moved by a first-class clerk as follows:—That the staff of the Central Telegraph Office and Metropolitan districts, here assembled, regret that the department has considered it advisable to take such unusual and severe measures against certain members of the Cardiff telegraph staff, and respectfully ask that an enquiry may be made into the circumstances, with a view to the reinstatement of those clerks, as the staff cannot but believe that these measures have been taken without the sanction of the Postmaster-General, or that that sanction was given without a full statement of the facts having been placed before him; and the meeting hereby resolves that a copy of this resolution be forwarded to the Postmaster-General. The speaker occasioned some amusement by announcing that he had received an anonymous communication worded as follows:—"Agitator—beware! Siberia awaits thee!"

The motion was seconded by a second-class clerk, who, in the course of his remarks, stated that only on one occasion had the contents of a telegram been divulged by a person in the Cardiff telegraph office; and the offender, he was proud to say, was not a telegraph clerk at all, but a higher official.

Mr. PRITCHARD MORGAN, M.P., supported the motion. He also disclaimed any political bias in the matter. Government servants suffering for six months under a great wrong had appealed to the public through the press, the public being their masters, against the misconduct of some other member of the Government service, who, whether it was the Postmaster-General or anyone else, was equally the servant of the public. Now that the matter had been ventilated it would receive the attention of the public inside and outside Parliament. The Cardiff clerks had been harshly treated. He did not think, however, that the blame would be found to lie with the Postmaster-General, but rather with some of those subordinate officers who, being clothed with a "little brief authority," had thought right to exercise it in disregard of the regulations provided by the late Mr. Fawcett, who at any rate had not been blind to the interests of his subordinates, and who had laid it down as a regulation that, after certain hours of overtime the amount payable for that overtime should be increased. He, the speaker, had made enquiries and had found that at the present moment that regulation was entirely disregarded; and not only that, but men, after years of faithful service were told that unless they played the spy upon their fellow employés, and unless they abandoned the inalienable right of Englishmen to complain, and disregarded the first law of nature, that of self-preservation, they were to be dismissed from the public service or degraded in some other way. Let them, however, be calm and allow those who were prepared to fight their battle, fight it in the proper field, and, if they failed, then would be the time to take more decisive action.

The resolution was passed unanimously.

The next resolution, which was proposed by a senior clerk, expressed the deep sympathy which the meeting felt with their *confréres*, who had been removed from Cardiff to other towns, and assured them of hearty support. The speaker questioned the legal right of the Postmaster-General to move men from one station to another at will; but to do so on mere suspicion was a grave injustice. The Cardiff men were the martyrs of twenty years of maladministration of the Cardiff telegraph office.

A second class clerk seconded the resolution, which was passed unanimously, three cheers being given for the Cardiff men.

One of the victims, who wore volunteer uniform, and was accorded an ovation, also spoke. He observed that his colleagues and himself had been transferred without any charge having been made against them. He read the official letter which had been sent him to announce his transfer to Worcester, and which concluded with the remark that his "future destiny would depend upon the consideration of the Postmaster General." He did not consider his transfer as a promotion, as it had been stated to be by the Postmaster General. There was no first class at Worcester, and the highest salary was only 30s. weekly. He denied having written to the press himself, and he did not belief that any of his colleagues had done so.

Resolutions expressing the grateful thanks of the meeting to the press throughout the United Kingdom, and particularly to the Cardiff *Western Mail*, for the hearty assistance rendered, were passed unanimously.

Telegrams expressive of sympathy from many of the most important cities and towns in Great Britain and Ireland were read to the meeting, which concluded with a hearty vote of thanks to the chair.

Electric Lighting at Croydon.—The Croydon Town Council have decided to support the application of the Croydon Electric Lighting Company for a provisional order, and to oppose that which is also to be made by the South of England House to House Electric Light Company, the latter having failed to come to an understanding with the authorities on the subject of the option of purchase after a specified period.

NOTES.

Brighton Lighting.—At a meeting of the Lighting Committee, on the 27th ult., a letter was read from Mr. Councillor E. A. Dell, suggesting that arrangements should be made with the Brighton and Hove Electric Light Company to place a light on the top of the fountain in Old Steine. Councillor R. Dell, referring to Councillor E. A. Dell's letter, said a letter had been received from the Electric Lighting Company, offering to take on the lighting of the town, in his opinion, at a greater benefit to the town as ratepayers than the scheme passed at the last Council, proposing to spend £30,000 in the first place. Councillor Tuff said the Committee had decided to engage an engineer to consult with theirs. Councillor Ewart said the Committee had been to see the electrical installation in London for themselves, and from that visit they had got more information than they would get from circulars, newspapers, or books in six months. As regarded a light on the fountain, if they wanted one he had no doubt in a few months the Committee would be perfectly capable of giving them one, steady, safe, and in every way to be approved of.

Electric Lighting at Bournemouth.—The objections to be lodged with the Board of Trade against the applications of the Brush Electrical Engineering Company, Limited, and the South of England House-to-House Electricity Company, have been drawn up and approved of by the Improvement Commissioners and copies have been forwarded to the Board of Trade and to the promoting companies. A clause was inserted in each provisional order, reserving to the Commissioners the right to apply for and obtain a provisional order at any future time, and also one empowering the Commissioners to buy up the undertaking of each of the promoters at any time they might think fit.

Electric Lighting at Amiens.—It is not very often that municipal councils become circus proprietors, although it occasionally happens that some town councillors act the part of clowns in electric lighting matters. From a letter which appears in the *Bulletin International de l'Electricité*, we learn that the Amiens Town Council introduced the electric light into the municipal circus some time ago. There are altogether 20 Cance arc lamps run in series, 16 being in the hall, and 4 outside. In addition to these there are 300 glow lamps used for the lighting and ornamentation of the building, stables, boxes and buffet. The current is supplied from Julien accumulators, there being four sets of 40 each, the total capacity being 2,400 ampère hours. The accumulators are charged by two dynamos, one of 170 ampères and 70 volts, and the other of 110 ampères and 70 volts. The dynamos are driven by two single cylinder condensing engines of 35 H.P. each, and which can be coupled together if required. Steam is supplied from a tubular boiler made by Velliet Brothers and Lescures. The Amiens municipality has just voted a large sum of money for the purchase of accumulators for the electric lighting of the local theatre and of various private establishments, and has concluded a contract with the Julien Company for the supply of the apparatus. The accumulators will be charged by the dynamos installed in the circus station.

The Electric Light at Eastbourne.—At the last meeting of the Eastbourne Town Council it was resolved to affix the corporate seal to the agreement to the recent proposal for the Electric Light Company applying to the Board of Trade for a provisional order.

Chelsea Lighting.—The St. George's (Hanover Square) Vestry has given its consent to the Chelsea Electricity Supply Company's application for a provisional order, authorising the company to supply electricity in the Knightsbridge and out wards of this parish.

Palace Lighting.—Lainz, the future residence of the Archduchess Valerie, of Austria, which is about four miles from Vienna, is to be fitted up with the electric light.

The Electric Lighting of Ironclads.—The French ironclad, *Le Hoche*, has been fitted with the electric light.

The Lighting of Northampton.—At a recent meeting the Town Council gave its consent to a provisional order applied for by the Northampton Electric Light and Power Company, Limited.

The Light at the British Museum.—The attendance since the light was installed has been one of great increase, and the arrangements are working smoothly.

International Cable Company.—The case of this company, in which A. S. Bolton petitioned for its winding up, has been again before the Chancery Division of the High Court of Justice. The petition sets forth that the company was incorporated with a capital of £1,000,000 in £10 shares, to lay cables between Portugal and the Azores, the West Indies, Canada, the United States, and Great Britain. It was stated that the Portugese concession for the cable between Portugal and the Azores having lapsed, was forfeited, and could never be renewed. It was further alleged that monies had been improperly paid to the promoters. On the other hand, it was argued that the petitioner was not supported by a single shareholder, and it was suggested that he was disappointed at not receiving any orders for copper wire to set off against his calls. Shareholders, respresenting £34,000, supported the petition; and shareholders holding 1,100 shares, and creditors to the amount of £700, opposed it. The petition was ordered to stand over until completion of cross-examination.

Royal Humane Society's Awards.—We have great pleasure in mentioning that the Royal Humane Society has granted its Honorary Testimonial to Mr. A. E. Saul, third officer, and to W. Brown, quartermaster, both of the Silvertown Company's telegraph ship *Buccaneer* (Capt. Barker), for the rescue of a sailor in imminent danger of drowning in the harbour of Penambuco. To jump from a ship into waters so infested by sharks, as is the harbour in question, was an act which certainly deserves full recognition. We understand that Mr. Saul, for some former rescue, was already the bearer of the Royal Humane Society's silver medal.

Scottish Telephone Directory.—A new directory has just been issued by the National Telephone Company, containing the name of every exchange subscriber in Scotland and Cumberland, corrected up to 31st December last. Accompanying the book, which is a well-printed volume of nearly 300 pages, is a map of the existing and proposed lines in central Scotland, and a preface giving information to users of the telephone. A special notice is inserted for the information of Aberdeen subscribers, to the effect that microphones have been fitted in the orchestra of the Theatre Royal, and any subscriber wishing to hear the music during a performance will be switched on as desired. We also learn that at the forthcoming International Exhibition at Edinburgh a special telephone exchange, with trunk line communication to Glasgow, Stirling, Fife, Dundee, and many other places, will be a feature of the exhibition.

Cable Ship News.—We learn that the *Mackay-Bennett* returned to her berth in the Victoria Docks, on Sunday, the 9th inst.

It is notified in shipping news that the *Britannia* passed Brow Head (South Coast of Ireland), on Saturday 8th inst.

H.M.T.S.S. *Monarch* returned to her moorings off Charlton on the evening of February 10th.

Price List of Insulated Wires.—Messrs. Shaw and Connolly, having now settled down in their extensive works at Newton Heath, Manchester, have issued two new catalogues, one giving the description and prices of "insulated wires for instruments, electric bells, telephone and telegraph purposes," and the other of "cables, wires, and sundries for electric lighting, transmission of power, &c." Both are beautifully printed in black, blue, and red, and are well arranged for ready reference. Messrs. Poole and White are appointed sole agents for the firm in London.

The Lacombe Carbons.—Mr. Holland Dell, late secretary to the Electrical Power Storage Company, has been appointed sole representative for the United Kingdom and Colonies of the well-known Paris carbon manufacturers, Messrs. Lacombe & Co., London. Offices, 7, Little Queen Street, Westminster, S.W.

As Light as Day.—When the Channel Tunnel is completed (?), it will, we are assured, be made as light as day, by means of electric lamps, and as compressed air will be the only motive power, the ventilation will be everything that can be desired.

Accumulators.—Sir David Salomons does not consider that there is any foreign secondary battery worth anything except those modelled on the best known English types. One would scarcely credit that half the so-called improvements abroad are simply old forms of British cells, now, like the dodo, extinct. From the vast amount of correspondence received by Sir David from all parts, and chiefly from professional men, he concludes that the whole civilised world look to this country as taking the lead in accumulator work. It may not be generally known that the author of "Accumulator Management," has a positive dislike to book-writing, and that his present standard work arose from the request of friends for a few rough and ready rules to guide them in controlling their installations. The book was written on the lines of question and answer, with sufficient text worked in to make the matter run on, and if still another edition is asked for, and this is almost a certainty, there will be at least some sixty new questions to answer, so it is quite clear that much still remains to be said on secondary batteries. Sir David might find some interesting matter for a new volume in the speeches delivered at Brighton, by Messrs. Killingworth Hedges and Ince.

Electricity in the East.—An Oriental poet, says a contemporary, might find a congenial theme in the illumination for the first time by the electric light of the famous Taj-Mahal in Agra in honour of the visit of Prince Albert Victor. The Taj-Mahal, as all who know anything of Indian history are aware, is the splendid sepulchre of white marble, adorned with the choicest of mosaics, which was erected at a cost of nearly a million sterling by the Emperor Shah Jehan for his beloved wife Noor Jehan, also called Noor Mahal ("Light of the World," "Light of the Empire"). It stands on a vast quadrangular enclosure, and forms a square building of great beauty. One light of immense power placed in the great bulbous centre dome, and four lesser lights on the surrounding minarets, gave a brilliant appearance to the whole structure, and cast a soft radiance far and wide over the crescent shaped-city.

Society of Arts.—On Tuesday, February 18th, at 5 p.m., a lecture will be delivered in the Foreign and Colonial Section on: "Ocean Penny Postage and Cheap Telegraph Communication between England and all Parts of the Empire and America." By J. Henniker Heaton, M.P.

Newspaper Science.—The following brilliant abstract appeared in the *Globe* of the 12th inst.:—"Execution by Electricity.—New York, Wednesday.—The Government Commission appointed to test the electric execution apparatus have issued their report. They find that a current of 900 volts transmitted through a German silver wire ensures death in four seconds."

High Tension Currents and Earth Connections.—"It is evident to any one having the most rudimentary knowledge of electricity, that the instant a wire is disconnected, all traces of electricity vanishes," so, at least, wrote Mr. Fawcus, of the Edison-Swan Company, Limited, in a letter to the *Manchester Guardian*; intending thereby to show that some recently reported "deaths from electricity," in America, could not be rightly charged to electricity, it being impossible for the wire to be capable of danger after being severed. On the other hand, Mr. H. A. Henderson, writing from 20, York Chambers, Brazenose Street, Manchester, points out that what practically occurred was an "earth connection," to which, he asserts, is principally due the many deaths and accidents that have been recorded. It is, he writes, "quite plain to see that the damp earth supplies, to a certain extent, the place of a metallic conductor. High tension currents are exceedingly fickle and unstable things, and have an uncomfortable habit of finding out paths and ways of their own. . . . Let electrical engineers, instead of attempting to deny the danger, turn their attention to providing means whereby it may be lessened, such as the abandonment of high tension systems, the laying of all wires underground in properly constructed conduits, and, above all, the perfect insulation of mains and branches at every point. I would refer your readers to an excellent article in the ELECTRICAL REVIEW for October 25th, 1889, which clearly states the danger and the way to avoid it."

State Purchase of the Telephones in Belgium.—The opinion is very generally expressed in Brussels, that the Government has decided to take over the telephone lines, hitherto belonging to different private companies. The working of the lines on the Belgium littoral, as is well-known, has been in its hands for a long time now. Recently, too, the Railway Posts and Telegraphs department has also taken possession of the telephone lines between Alost and Termonde and Saint Nicholas and Lokeren, and now the Government, it is stated, has determined upon other acquisitions. As an indication of this, it may be mentioned that the public telephone offices in Brussels and Liége, have been placed under the direction of the Ministry of Railways, Posts and Telegraphs, and some of the telegraph staff are working them.

Convincing Figures.—The immense advantage possessed by electricity as an illuminant, in point of safety, is well shown by the comparisons in the following table, which gives the number of fires with the amount of property and insurance losses, due to illuminating agents during the year 1888 in the United States :—

Cause.	No. of Fires.	Property loss.	Insurance loss.
Candles	84	66,723	52,496
Gas and gasolene explosions ...	93	480,539	323,994
Lamp and lantern ditto ...	528	1,047,651	655,689
Oil and gas and oil stoves ditto.	117	377,191	120,118
Gas jets	179	281,233	236,468
Lamp and lantern accidents ...	190	420,006	260,848
Matches	592	1,416,437	704,735
Total from above causes ...	1,783	4,089.780	2,354,348
Electric wires and lights ...	49	887,351	414,998

Popp's System.—The International Popp'sche Druckluft und Electricitäts Gesellschaft, which has been formed to work Popp's system of compressed air, and also electricity, was constituted last week in Germany, with a capital of 30,000,000 marks. The following companies and firms are among the promoters: Disconto Gesselschaft, Berlin; Dresdner Bank, Berlin; Norddeutsche Bank, Hamburg; Sal. Oppenheim, jun., Cologne; Gebr. Bethmann, Frankfort-on-the-Maine; and Fink & Co., Munich.

A Deadlock at Bridlington.—At a recent meeting of the Bridlington Local Board, a tender by the local Gas Company, offering to light the town for £800 per annum, also one by Messrs. Laing, Wharton and Down, offering to do it for five years at £900 per annum, were considered. A motion by the Chairman of the Lighting Committee that the latter tender be accepted, was followed by an amendment from a Mr. Creaser, pledging the board to accept the Gas Company's offer. The right of this gentleman and also of two other members of the board to vote on the question being challenged, on the ground that they held shares in the Gas Company, it was ruled that they could vote for the tender of the Gas Company but not against the electric light. On the amendment being put to the meeting there voted for it the mover and seconder and four against it, therefore the Gas Company's tender was not accepted. The resolution accepting the tender for the electric light was then put, when four members voted for it and six against it, including the three shareholders in the Gas Company, and it was declared not carried, the result being that after the 25th of March, unless some arrangement is come to, the town will cease to be lighted.

The Old, Old Story.—The primitive method of searching for an escape of gas by means of a naked light appears to be on the increase, for instances are now of frequent occurrence, one of the latest having occurred at Barnsley, where we should have thought that they would have known better. Instead of an escape occurring in a house, it seems to have been in the ground and the gas accumulated in the street boxes belonging to the Postal underground system to such an extent that the Postal authorities complained. The foreman of the gas works, accompanied by some other men, went to inspect a box which is situated at the top of Eldon Street North, the foreman struck a light and immediately an explosion took place. The stone and iron covering of the box, weighing about 1 cwt., were blown into the air a distance of 50 yards. The foreman, we learn, had a miraculous escape, but was cut in the face by small pieces of stone and was slightly burnt. As Barnsley has made up its mind to have the electric light, it would be advisable to have closed conduits if the escape of gas is not attended to.

A Breach of Confidence.—Prof. Charles R. Cross, of the Massachusetts Institute of Technology, disclaims all connection with the transformer tests which were published in the REVIEW of the 31st ult., and said to be issued under his authority. He states that the results were given entirely without his assent, and he considers that their publication involves a breach of confidence on the part of someone at present unknown. The Professor says that tests were made by two of the students as part of an original thesis, but partly on account of what Mr. Marshall inserted, and still more by reason of omissions, Mr. Cross does not hesitate to call the article misleading. He also wishes it to be understood that he is quite unacquainted with the gentleman whose name is attached to the paper. It is not suggested that the very high values obtained from the Westinghouse transformer are seriously in error, but, that on the contrary, they show with approximate accuracy what figures can be obtained from a well-made converter under favourable conditions. Probably the *Electrical World* or the Westinghouse Company can explain the matter!

Contracts.—Messrs. Woodhouse and Rawson United have just obtained a contract for the wiring of the Russell Court premises of the Hansard Publishing Union. One feature of the lighting will be the employment of two 30-ampere arc lamps for carrying on the Vanoni process of photogravure. Two other contracts have also been made, and in one of these two installations some high candle-power glow lamps will be used.

The Institution of Electrical Engineers.—The students of the institution met last Friday to discuss Mr. Mordey's paper on "Alternate Current Working," Mr. W. B. Esson in the chair. The meeting first confirmed the election of the following committee for 1890. Mr. A. E. Childs, S. L. Horn, J. A. Muir, G. Müller, G. H. Thornton, H. Walker. D. S. Barton, hon. sec. Mr. Müller then made some opening remarks on the above paper and the discussion was continued by the Chairman, Messrs. Wightman, Walker, Horn and Raphael, and a vote of thanks to Mr. Esson terminated the proceedings.

A Feather in their Cap.—The *Journal für Gasbeleuchtung* relates the following anecdote:—Mr. Edison, in the course of a conversation with a well-known Berlin electrician, about the electric lighting of great cities, remarked that there was only one splendidly lighted street in Paris, viz., the Avenue de l'Opera. "Which Company lights it?" enquired the electrician. "The Gas Company," was the unexpected reply.

Electricity on the Nile.—On Tuesday the 28th ult., H.H. the Khedive inspected Messrs. Smith & Co.'s new tourist steamer, *Rameses the Great*, by electric light. This steamer, which was constructed on the Clyde, and is the largest and finest on the Nile, is fitted with all modern improvements, including electric light, electric bells, &c., &c.

Manchester Square Station.—The building of this station, which is situated in South Mews, Manchester Square, will shortly be completed. The foundations for the boilers and dynamos are now being laid.

Bacchus as an Enlightener.—One of the most striking objects at the Venetian *fête*, recently inaugurated at the Leinster Hall, Dublin, by the Marchioness of Londonderry, the funds of which are to be devoted to the Dental Hospital of Ireland, was a bronze statue of Bacchus holding aloft a cluster of nine electric lights.

The Relighting of New York.—A gentleman, who is said to practically represent all of the electric lighting companies, asserts that the city will be relighted by electricity within 60 days. This was said on February 1st. Wherever there is a subway it will be occupied by electric wires; where there are no subways overhead wires will be used.

New South Wales Postal Statistics.—On December 31st, 1889, the number of post-offices open was 596. During 1889 there passed through the post—letters and postcards, 17,136,097; packets, 841,362; newspapers, 8,056,098; the number of telegraph stations open on December 31st in 1889 was 210; local and intercolonial telegrams transmitted was 918,454; the number of telegrams to the colonies, 31,669—value, £161,311; number from the colonies, 30,945—value, £162,725; total number of telegrams, 62,614—total value, £324,036; proportion accruing to South Australia, £37,508; telegraph lines—erected, 145½ miles; dismantled, 145½ miles; in progress, 11½ miles; total length of lines open for traffic, 5,436¼ miles; telegraph wires—erected, 291 miles; dismantled, 145½ miles; in progress, 23¼ miles; total length of wires open for traffic, 9,921 miles; telephone extensions—wires erected, 105½ miles; total length of telephone wires open for traffic, 1,778 miles; total length of telegraph and telephone wires open for traffic, 11,699 miles. The telephone exchanges number 600 subscribers; a multiple switchboard for 1,000 subscribers has been ordered, and provision made for further extension to 1,500. The year's revenue of the department was £208,118; expenditure, £178,440.

Electricity in the States.—The total number of central stations in the United States is, according to the latest return, 1,265. The total number of gas companies is 981, and of these 237 operate electric light plants in conjunction with their gas business. The number of electric railways is 162.

International Exhibition at the Agricultural Hall.—As will be seen by an advertisement in this issue, the promoters of the International Exhibition of Machinery, Manufactures, and Inventions incidental to Engineers, Electricians, &c., have opened the competition for the electric lighting of the Agricultural Hall during the holding of the exhibition from the 17th to the 29th March, and for which a prize of £100 will be given. Steam, or other power, will be provided free of charge to the successful competitor. Further particulars were given in our issue of the 24th January. Offers are to be sent in to the manager, or secretary, at the offices, 43, New Oxford Street, W.C.

The Inventor of the Electro-Magnet.—Sturgeon's right to be considered as the inventor of the horse shoe shaped electro-magnet is rather contested by Mr. T. Gilliard in a letter to the *Mechanical World*. This gentleman recollects Mr. Richard Roberts, C.E., showing him an electro-magnet similar to that described by Dr. Silvanus Thompson, and which had taken a medal and premium at the Society of Arts, somewhere about 1825. This, curiously enough, is the date mentioned by Dr. Thompson, as that at which Sturgeon contributed a paper to the Society of Arts describing his alleged invention. The writer thinks that perhaps among the collection of Roberts's inventions at Peel Park Museum, Salford, this magnet could be found.

Personal Insulation.—Superintendent Jacob Pfetch, of the Erie Motor Car Company, says an American contemporary, has invented a method of insulation which will enable linesmen and others to handle any wire with safety. The first public test of the new invention took place in the presence of members of the electrical profession. Pfetch having fortified himself, took hold of the buzz (*sic*) rod of the dynamos in his bare hands, which he had dipped in water, he then stepped upon a pile of wet dirt and received the full charge of 500 volts, the force used to operate about ten miles of road. To everybody's surprise the electricity did not ground and Pfetch felt no effects whatever!

Shocking Fatality at West Drayton.—Dr. Danford Thomas held an inquest at Marylebone Coroner's Court concerning the death of Sydney Myers, aged sixteen a pupil at the works of the Electrical Engineering Company, at West Drayton, the son of a manufacturing stationer, of 168, Sutherland Avenue. John Cushney, the manager of the works named, deposed that the deceased had been six months at the factory. On Wednesday last week Myers had occasion to enter the room where the dynamos were tested for the purpose of marking some resistance coils. To reach these coils, which were hung upon rectangular frames fastened to the wall, it was necessary he should stand on some boxes near a revolving shaft, which made 170 or 180 revolutions a minute. Witness presently noticed the deceased "doubled up and going round with the shaft." Wires which he had been marking, and probably holding in his hands, were bound round the boy and the shaft. He was tied tightly to the shaft by the wires. The steam was shut off, and he was extricated as soon as possible. Before he began his work of marking, Myers should, by the rules of the establishment, have stopped the shaft, which he could easily have done by simply pulling a handle. Mr. Statter, a director of the company, said if the deceased had told the foreman that he had work to do behind the shaft, the foreman would have stopped it. Other evidence showed that the deceased died shortly after the accident, at St. Mary's Hospital, from internal hæmorrhage, following fractured ribs and other injuries. Mr. Gould, Inspector of Factories, who was present, said he intended examining the shaft, which was unprotected. The jury, in returning a verdict of "Accidental death," suggested that the shaft should be protected, "if possible."

Balloon Society and Electricity.—Mr. G. Offor will deliver a lecture in connection with the above society on Friday, 21st inst., in St. James' Hall, on "The action of local authorities and the Board of Trade with regard to the supply of electricity."

French Copper Syndicate.—The *Daily News* learns that writs were issued in France, on Monday, against the most influential members of the copper syndicate.

NEW COMPANIES REGISTERED.

Trent Gas Engine Company, Limited.—Capital, £15,000 in £10 shares. Objects: To acquire certain British and foreign patents granted to Richard Simon for improvements in or connected with gas engines. To manufacture and deal with apparatus and appliances for the generation, distribution, supply, accumulation, and employment of electricity, and generally to carry on the business of electricians and engineers in all branches. Signatories (with 1 share each): *Edward Goldschmidt, *J. B. Hutchinson, *S. Baggaley, Wm. Lee, Wm. Hunt, all of Nottingham; Hugh Nettlefold, Broad Street, Birmingham. The first three signatories are appointed directors; qualification, 25 shares. The company in general meeting will determine remuneration. Registered 6th inst. by R. Jordan, stationer, 120, Chancery Lane.

Lane-Fox Electrical Company, Limited.—Capital, £100 in £1 shares. Objects: To carry on in all branches the business of electrical engineers, electricians, practical engineers and contractors, manufacturers of electrical apparatus, mechanical and chemical engineers, and of producing, storing, and supplying light, heat, sound, and power by electricity, galvanism or magnetism. Signatories: St. George Lane-Fox, 50, South Eaton Place, 73 shares; C. A. Stephenson, 90, Inverness Terrace, W., 2 shares; W. J. Grove, J.P., Salisbury, 2 shares; Bernard Drake and J. Marshall Gorham, both of 66, Victoria Street, S.W., 5 shares each; Wm. Lane Fox Pitt, Grenadier Guards, 4, Grosvenor Gardens, 12 shares; J. Cobden Sanderson Goodyers, Hendon, 1 share. The signatories are the first directors; remuneration, £1 each per meeting, and also 7 per cent. of annual profits available for dividend. Mr. St. George Lane-Fox is appointed chairman. Registered 6th inst. by Sydney Morse, 4, Fenchurch Avenue. Registered office, 2, Prince's Mansions, Victoria Street.

Fareham Electric Light Company, Limited.—Capital, £5,000 in £1 shares. Objects: To adopt an agreement of 3rd inst. with James Blake, of Fareham, Southampton, for the sale to the company of certain electric lighting machinery and plant. To carry on at Fareham and elsewhere the business of an electric lighting company in all branches. Signatories (with 1 share each): Capt. John Ramsay, R.E., Rear-Admiral Samuel Townsend, Jno. Griffiths, J. H. Kettle, E. Cawte, G. Whitlock, all of Fareham; C. J. Wharton, 82A, New Bond Street. Registered 8th inst., without special articles of association, by H. F. Kite, 11, Queen Victoria Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Woodhouse and Rawson United, Limited.—An agreement of the 13th ult. (filed 7th inst.) between James Thorne, of 85, Gracechurch Street, merchant, and this company, cites that letters patent, dated 22nd May, 1886, No. 6931, were granted to Mr. Thorne for improved apparatus for indicating the speed of rotating shafts, communicated from abroad by Dr. Theodore Horn, of Leipzig. The vendor has agreed to dispose of the patent to the company for £450 cash, £500 in fully paid preference shares and a royalty of 15 per cent. on each instrument manufactured during the continuance of the patent. The original arrangement between the vendor and Dr. T. Horn provided for the manufacture of articles under the said patent by Dr Horn at a maximum charge of 20 per cent. less than the price list price. Before completing the purchase the vendor undertakes to obtain from Dr. Horn for the company the sole right of manufacturing the instruments.

An agreement of 29th ult. (filed 7th inst.) between this company of the first part, the Woodhouse and Rawson Electric Contract and Maintenance Company, Limited (in liquidation), of the second part, and G. A. Steinthal of 41, Piccadilly, Bradford, cites that the present company is indebted to the company of the second part in the sum of £6,000 as the consideration for the purchase of the businesses of that company. This amount the company of the second part has agreed to accept in fully paid preference shares of this company, and the same will therefore be allotted to the nominees of the liquidator.

Automatic Electric Railway Signal Company, Limited.—The annual return of this company, made up to the 14th ult., was filed on the 7th inst. The nominal capital is £100,000 in £1 shares. 72,832 shares have been taken up, 69,750 being considered fully paid. Upon 3,082 shares the full amount has been called, the total calls paid being £3,079 10s., and unpaid £2 10s. The sum of £28 2s. 6d. has been paid upon 355 shares forfeited. Registered office, 11, Runcford Place, Liverpool.

Portland Electric Light Company, Limited.—The annual return of this company, made up to the 13th ult., was filed on the 5th inst. The nominal capital is £45,000 in £5 shares, but although the company has now been in existence over two years, only seven shares have been subscribed for. Registered office, 48, Osnaburgh Street, N.W.

Electrical Purification Association, Limited.—At an extraordinary general meeting of the members, held at 8, St. Martin's Place, Trafalgar Square, on the 14th ult., the following resolution was passed and was duly confirmed on the 30th ult.:—

"That the capital of the association be increased to £25,000 by the creation of 10,000 new shares of £1 each, such new shares to rank *pari passu* with the existing shares, and subject to the conditions of the present articles of association." The formal notice of increased capital, required under section 34 of the Companies Act, 1862, was duly filed on the 4th inst.

T. Potter and Sons, Limited.—An agreement of 11th December (filed 11th January) provides for the purchase by the company of the business of T. Potter and Sons, of 44, South Molton Street, and West End, Hampstead, engineers, brass and iron founders, electric light, sanitary and general engineers. As consideration for the purchase the shares subscribed for Thos. Potter and Hy. Arthur Potter shall be deemed to be fully paid, and numbered 1 to 20 and 20 to 520 inclusive. As residue of the consideration, the company is to discharge the debts and liabilities of the vendors in relation to the said business, including £4,000 due to Thomas Potter, senior, which amount will be paid in debentures.

CITY NOTES, REPORTS, MEETINGS, &c.

Chelsea Electricity Supply Company, Limited.

THE ordinary annual general meeting of the Chelsea Electricity Supply Company, Limited, will be held at their central station, Draycott Place, Sloane Square, London, S.W., on Wednesday, the 19th day of February, 1890, at 12 o'clock noon, for the purposes of receiving the report of the directors and the accounts for the year 1889, and of transacting the ordinary business of the company.

The sub-joined resolution will be proposed at the meeting:—"That the directors be, and they are hereby authorised to borrow a sum not exceeding £50,000, and to secure the same by the issue of debentures in such form, secured in such manner, and issued to such persons on such terms and at such times as the directors may deem expedient."

The transfer books of the corporation will be closed from the 12th to the 20th day of February inclusive.

The following report will be presented by the directors :—

Up to May, 1888, when the last report was issued, the company had only been able to take preliminary steps for its development. In July of that year the Electric Lighting Bill, introduced in Parliament by Lord Thurlow, having passed both Houses, the board of directors was re-formed, and a prospectus was published. The capital requisite to proceed with the construction of a generating station, and to put down the necessary plant for the distribution of electricity within the first area of supply, as included in their Act, was then obtained.

The necessary contracts for building and plant having been made, work was commenced in the latter end of 1888, and in an unprecedented short time the central station was completed, under the supervision of the company's architect, Mr. F. G. Knight, of 6, Great College Street, Westminster.

Early in April, 1889, the station was so far ready that experimental plant was put to work, but owing to a delay in supplying the engines arising out of the destruction by fire of the works of Messrs. Willans and Robinson, of Thames Ditton, and several other causes, the period of experiment and preparation continued until the end of September, after which the work of regular and extended supply came into operation. At the outset the company had to encounter competition within its area of supply of two other companies, neither of which were operating under Parliamentary powers.

These companies proposed to invade the district with overhead lines, and thus take advantage of the uncertainty of the law on the subject to obtain some custom at a comparatively small outlay. By strenuous opposition, by actively pushing on the completion of its works, and by subsequently entering into a friendly arrangement (approved by the Board of Trade and the Chelsea Vestry) with one of those companies, the company has succeeded in neutralising any effect which this desultory competition might have otherwise had on its business.

At the Board of Trade enquiry held at Westminster Town Hall in March and April, 1889, the company, represented by Mr. Fletcher Moulton, Q.C., and Mr. R. S. Wright, successfully defended its position, and succeeded in showing that the system it had adopted, now commonly known as the *Chelsea system*, was at least equal to any other system under enquiry. One result of this enquiry was that the company, with the consent of the Kensington Vestry, obtained a provisional order for a part of that parish, known as the South Kensington electric lighting order, 1889.

The contracts for the plant to extend the system into Kensington, were again undertaken by the three contracting companies, namely: the Brush Electrical Engineering Company, Limited, the Callender's Bitumen Telegraph and Waterproof Company, Limited, the Electric Construction Corporation, Limited. These companies agreed to receive payment in fully paid up shares of the Chelsea Company.

Since early in December current has been supplied in South Kensington.

The company has obtained the sanction of the Board of Trade, and of the Chelsea Vestry, to extensions of their area of supply on the south, and on the north of their first area up to Knightsbridge, including the Lowndes Square district. They have nearly completed the erection of a fourth storage station at the northern end of Pavilion Road, and have made all the arrangements for laying down the necessary mains throughout those areas.

In the erection of the company's central stations, the directors were obliged to provide a building of sufficient capacity for all probable future demands and extensions of area of supply.

The building includes space for a generating plant to supply a total of 30,000 (8 to 10 candle-power) lamps in use at one time, representing a to total of 60,000 installed. Besides, it contains one storage station, the necessary offices, and residential accommodation for some of the staff. The outlying storage stations of the company in use, or about to be put to use, are in Clabon Mews, Pavilion Road, and Egerton Gardens, and negotiations are in hand for a fourth.

The company has received many testimonials from its customers, expressing the most marked approval of the system of supply. The causes for this satisfaction continue, and they may be chiefly traced to the perfect steadiness of the light, and the consequent economy of wear and tear of glow lamps, and total absence of any interruptions to the light which the system secures.

The steady and gratifying growth of the company's business is exemplified by the following statement. The table shows the relation between *running* and *revenue* expenses in the months of October, November, and December, 1889, being the first regular quarter, and bears remarkable evidence of the proportionate increase of income, as compared with expenses as custom extends.

Statement showing actal cost (exclusive of general charges) of running machinery and storage stations, and the revenue received for current supplied during the three months ending 31st December, 1889.

	£	s.	d.
October—coal, water, oil, waste and wages, removal of ashes and fitters' time...	82	0	10
November " " " "	114	14	0
December " " " "	141	9	6
October—current invoiced	146	1	6
November " "	262	8	2
December " "	405	12	0

In order to complete the works in hand, and to be ready to meet the cost of the necessary extensions, the directors seek the approval of the shareholders to the creation of debentures to the amount of £50,000.

The retiring directors are Major-General Webber and Mr. Daniell, who, being eligible, offer themselves for re-election.

The auditors, Messrs. Cooper Brothers and Company, also offer themselves for re-election.

The profit and loss account shows expenses £845 17s. 11d., revenue for current, &c., £1,025 7s. 8d., balance £179 9s. 9d.

The India-rubber, Gutta Percha and Telegraph Works Company, Limited.

IN the directors' report for the year ending December 31st, 1889, to be presented at the 26th ordinary general meeting of the shareholders, to be held at the Cannon Street Hotel, London, on Friday, 14th February, 1890, at half-past one o'clock in the afternoon. The acconnts show the net profit for the past year to be £57,748 9s. 1d., adding £25,087 17s. 7d. brought forward, and deducting £20,800 interim dividend paid in July, there remains a disposable balance of £62,036 6s. 8d. The directors recommend the distribution of a dividend of 10s. per share, free of income tax, amounting to £20,800, making with the interim dividend, a total payment for the year of 10 per cent., and leaving £41,236 6s. 8d. to be carried forward. The company's general business has been well maintained; and the laying of the 800 miles of cable mentioned in the last report was successfully completed. At the instigation of unprincipled agitators, almost all the company's workpeople went out on strike in the middle of September, and remained out from 10 to 12 weeks. The result to them was the loss of about £20,000 which they would have received in wages. The loss to the company was but small, as other means were available for the execution of orders. For the greater convenience of the company's business, freehold premises have been purchased at Liverpool adjoining those hitherto occupied, the lease of which runs out in the present year; and, in consideration of an extended lease at a reduced rent, the premises in Cannon Street have been re-arranged and greatly improved, and fitted with electric light. The company's works and machinery are in efficient working order. Mr. Silver and the Hon. Henry Marsham, the directors retiring by rotation, offer themselves for re-election. The auditor, Mr. Weise, retires, and is re-eligible.

Société Générale des Téléphones.

THE extraordinary general meeting of the shareholders of this company has just taken place in Paris. In order to avoid any heated discussion as to M. Coulon's acquisition of the telephones on behalf of the State, which was looked upon as being very detrimental to the shareholders' interests, the directors had put off the meeting for some weeks. In a very moderate statement the directors give a history of the acts which had for their results dispossession in spite of common law. They also formulated the proceedings which they felt constrained to take in order to safeguard the interests confided to them. The meeting, after hearing the report read, unanimously approved the directors conduct as regarded the measures taken for defending the shareholders' interests; it also approved, not less unanimously, the projects of the managing council for developing the company's business, and passed votes of thanks warmly congratulating the directors. It is believed that one of the three actions before the Council of State will be called on very shortly. These actions have been undertaken by MM. Lair and May, acting as president and vice-president of the Société Générale des Téléphones representing in their names their own and the interests of the shareholders, in whose names they signed the proposal of March 6th, 1886, the treaty of July 22nd, 1886, and that of November 25th, 1886. The first action has as its object the proving of the powers of MM. Lair and May to act in the names of the shareholders and not in their own names, as the State wished to demonstrate, in order to have fuller liberty of action. MM. Roger-Marvaise and Waldeck-Rosseau will be the counsel for the company.

Brush Electrical Engineering Company. — The directors have decided to pay an interim dividend upon the preference shares of the above company, and warrants for a dividend on these shares at the rate of 6 per cent. per annum from August 10th, 1889 (the date of the registration of the company), to February 10th, 1890, will be issued on the 1st proximo. As the books of the company will not be made up until the close of the year, the directors defer the question of a dividend on the ordinary shares until the complete accounts are before them.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending February 7th, 1890, amounted to £5,014.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 7th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,804.

ELECTRICAL EXPERTS ON THE BRIGHTON LIGHTING.

LAST Friday night a public meeting was held at Brighton for the purpose of passing a resolution condemning the proposed scheme of the council. There were present on the platform Mr. Killingworth Hedges and Mr. F. Ince, of London. After the scheme had been fully set forth by the chairman (Councillor Ballard),

Mr. KILLINGWORTH HEDGES said he had been pressed to make a few remarks on the proposed installation. A report in a daily newspaper was only put into his hands a few hours ago, so that he had only been able to look into it in a cursory manner and could not go into all the details, in fact it was not necessary to go into many details. There were two questions. Were they going, here in Brighton, to have the best and most recent development of electric science; and, secondly, when they had it would they be able to maintain it and make it as perfect as they were promised in the report? The first was as regarded the system.

Looking at the report of Mr. Shoolbred, who had advised the Corporation, he found he had at the beginning gone fully into the relative merits of the two systems of electric lighting, the alternating current—where the current flowed in different directions—or the high tension system, as it was called, and the continuous current or low pressure or storage system. He had given a good description of these two, but he was extremely prejudiced against the first system, and contended that they were to be saddled with the second one. They ought to know something of this high pressure system, because it was the one that had been working in Brighton for some years. In London he had heard little complaint of it and had not seen anything in the newspapers. But even if the thing did not work so well as it might, it must be remembered that the installation was put up in a more or less temporary manner with overhead wires. If they could work well with overhead wires they might be certain they could work much better with underground wires; therefore, let them disabuse *their minds from trifling accidents or extinction of life*, which might have occurred, in considering the project they were now going to embark in. If the present company was allowed to extend, or even to continue to exist, they could not continue with overhead wires, as the Board of Trade had said that within a given time all electric light wires were to be put underground. Going back to the alternating current, he said he did not see why Mr. Shoolbred should have chosen this continuous current system here.

He (the speaker) had made it a study to see as much as he could of the big installations of electric light and successful installations of electric light in America and in the different countries of Europe, and he had noticed that the high pressure system was continually increasing. He did not say the other system was not there, because there was a great deal of it. In America a few years ago there were ten or twenty installations on the Westinghouse system, which was the high pressure or alternating system, and it was just the same in Europe. In Paris, after a most careful investigation as to the best system to be adopted for the centre of the city they adopted a high pressure system, and those who had been there must have noticed the extremely pretty effect the long lines of lamps had in the centre of the boulevards. He believed they were very successful. Again, they were going to light the greater part of Rome by electricity, and to use the water-power from the falls of Tivoli, many miles off, and this would be impossible except with the high pressure system. He mentioned these instances to show that the plan which had been working in Brighton so long was not dead, and had not been superseded. In fact, he did not know they could have a better plan, although it would be cheaper, if on a larger scale, than the one at present at work here under private enterprise.

It was quite true that if they did not use storage batteries—and he noticed that Mr. Shoolbred made a great point of storage batteries—they must have a second engine and a second electrical machine or dynamo, as it was called, ready to start at a moment's notice. But, after all, they must have the same thing if they had storage batteries. It would not do to rely upon one machine, because accidents did happen, and if they had an accident with an engine or an electrical machine, it might be such a bad one that it might take two days to repair. (A Voice: "And a week sometimes.") Yes; and a week sometimes. They must have the plant, whether they had storage or not. As a friend of his, with a great deal more experience than himself, said of storage batteries, they are splendid things to look at, but you must not work them. They kept the light steady, but the cost of depreciation eat up all the profits. With storage batteries one had all the disadvantages of the alternating current system, and none of the advantages. He saw from Mr. Shoolbred's report that there were to be three stations, or more, at Brighton. He would come to the question whether it would be possible, with the amount of money it was proposed to expend, to put up three stations, but if they had the alternating current they could have one, or, say, two stations—not to light the small portion of Brighton that was proposed to be lighted with the three stations under the storage system, but to light the whole of Brighton. They had all heard, he supposed, of the wonderful work being done at Deptford by the London Electrical Supply Company. They had a station there occupying about four acres of ground, and capable of lighting nearly three million lights when completed. That was more than they would want in Brighton (laughter). The advantages were so great, that supposing they had anything of that kind they could put dirt and smoke right out of the town, and more than that, they could put it where coals could be obtained cheaper. If they had a natural water supply they could put it whether the water was cheap or not. The cost of water was a most important element. At Deptford they took water from the river, and it did not cost them anything.

But he did not wish to go at too great length into the relative merits of the systems, though he might mention that if they had three stations, as Mr. Shoolbred proposed, they must have three sets of employés and managers or deputy-managers, so that upon this question of staff alone three stations must be more expensive than one. Now as to the question of cost. He said when he commenced to address them that he had not seen the details of Mr. Shoolbred's scheme, so that it was only fair to the gentleman who drew it up to allow that there might be something omitted, and he could not help thinking that there must have been something omitted, because it appeared to him that £30,000 was a very low estimate. About a year ago there was a very long discussion as to the relative merits of the various systems of electric lighting, and the advocates of this low tension or battery system drew out a sort of estimate which they placed at their Institute of Electrical Engineers. He had a copy of it, and he found that Mr. Shoolbred's was very much lower than their estimate, and they, of course, viewed the matter from a sanguine point of view. Taking that estimate he could not understand how Mr. Shoolbred was going to make even one station for £30,000, and if he was going to have three stations he should say that £100,000 would be nearer the cost.

The next question was the question of price. He noticed that it was intended to charge sixpence per unit. But he had before him the working expenses of a company established in London, and which was supplying 5,000 lights—the number which Mr. Shoolbred said was actually going to be supplied by his scheme. He found they did not sell at 6d., but 8d. per unit. But suppose that they did sell at sixpence, they would have been at a loss of about £264 on the year's working. As a matter of fact, they sold at eightpence, and that about cleared them. He did not think it would be possible to make both ends meet at Brighton by selling at sixpence per unit. It was best to face these things at first, because it was not likely that they would allow their money to be wasted, and, on the other hand, the public would not like the price to be raised. In one of the papers—he believed it was in Mr. Hallett's—he noticed it stated that these storage batteries could be kept in order at a cost of about 12 per cent. per annum. (A Voice: "12½.") Well, he did not think that could be done. It might be done where the undertaking was a very large one, but these were special things, and they required special men to look after them. In the course of time they would have men able to do it at ordinary wages, but at present he thought it was only right that these men who had devoted their time to this particular business should be paid well. He did not see how they were going to do it for £250 a year. Certain portions of the batteries had to be renewed, and if they could do it at 12 per cent. the company in London to which he had referred were paying a great deal too much.

He had not had time to read the report of Alderman Hallett, but it appeared from just glancing at it to have something quite novel about it, and that was the suggestion as to employing a gas engine as the motive power. They all knew what a gas engine was, and for making sausages, or turning sewing machines, or even printing machines, it was a splendid agent; but when it came to larger undertakings it had many disadvantages. You were placed at the mercy of the gas company. In case of fog and they ran short of supply you could not work your gas engine unless you had put up gasometers. He would like to ask Alderman Hallett whether he had ever seen these big gas engines started. He unfortunately used to work where a gas engine was used, and it was not so big as those Alderman Hallett advocated, but they all had to give a hand to start it. He was rather afraid that the number of men Alderman Hallett intended to employ would be insufficient to start the engine; he would have to bring men in from the street. He could not quite follow Alderman Hallett's estimate of power, Alderman Hallett said that two 21 horse-power engines, nominal, would be sufficient with a third as reserve; and then spoke of 2,000 lamps. But 2,000 lamps would take 200 horse-power. He would allow that 21 nominal worked out at 50 horse-power. That gave 100 horse-power, but how 100 horse-power was going to work 2,000 lamps was rather a difficult problem.

He must apologise for addressing them at such length, but he wanted particularly before he sat down to congratulate them upon the progress that was being made, because he thought it was a step in the right direction to have the electric light. Other watering places had it, and he was sure that Brighton's beautiful promenade would be improved by it. But at the same time he did not see why they wanted to quarrel with people who had hitherto, he understood, worked very successfully, and had been pioneers in the enterprise. He thought that people who invested their money in these enterprises ought to be looked upon in a patriotic spirit. It was not a monopoly for life like a gas or water monopoly; it was only for a certain period; and then there were very ugly clauses put in as regarded compulsory purchase, and then there was no chance of those dividends that one heard the gas and water companies paid. There would never be such opportunities for them, and it was a pity to stop an enterprise of this kind. Although it was the first time that he had had the honour of meeting them it was not his first appearance in Brighton in connection with electric lighting because about ten years ago he came here, and was allowed to put up high-class gasburners in the Steine ("We recollect you well"). Did they? (laughter). Anyhow he got no thanks, and no appreciation was shown; in fact, he was told that it was a foolish thing altogether. It had, however, been proved that the Corporation had thought better of it since then, and he was glad to see that they had now those high-power gaslights on the parade. At the same time, the next time he came down to Brighton he hoped to see them removed, and in their place the arc lamp, which gave a more diffuse light, and which he believed would be cheaper. He would remind them, in conclusion, of what they said in America, that one arc light was as good as two policemen (laughter and applause).

The CHAIRMAN said it must not be supposed that it was the intention of the Council to light one single lamp in the streets. If it were a matter of public utility he would not have taken the step he had. Not one of them would have a view of the light except it were in the shop of someone who used it.

Mr. F. INCE, of London, then addressed the meeting, remarking that he would, in the first place, tell them who he was. The science of electricity had been one of the hobbies of his life, a hobby which he never anticipated would have been brought, in his case, to any commercial advantage. His love of science brought him in contact with Mr. Ferranti. Discussing with him, and considering the future of electrical science, he was forced to a certain extent to consider how they could deal with the great problem of the lighting of London. Of course, before attempting to deal with lighting on a large scale in London, they naturally considered how they shonld spend their money, and what would be the best way of lighting London most effectively, and at the lowest cost, and he became associated with a few friends who, between them, subscribed £1,250,000, with which they had started their undertaking in London, an undertaking which meant from their present station to light 3,000,000 lamps. After considering every known system of lighting by electricity, they came to the conclusion that it would be useless to attempt to light London by storage batteries, and ultimately they adopted the high-pressure illuminating system. The first who were associated with him, and were his colleagues on the board of the London Electric Supply Corporation, put their names down for various sums. One put down a little over £200,000, another director had about £80,000, another £60,000, and he thought he was himself about the smallest holder in the company, and his amount was £12,000. He would let them know at once he was associated with Mr. Ferranti, an association he is not ashamed of, and he mentioned this because he daresay some kind friend in some of the local literature might say he came down to Brighton to advocate the system of his partner, Mr. Ferranti. He did advocate that system, and most strongly, but he had the courage of his opinion, and had ventured a large sum to back his opinion, and not only in that company, but in others working on the same lines he had probably £80,000 invested.

Brighton, they must consider, was popularly and very rightly called London at the seaside. It was a second London, and the area made it important for them to use the high tension system. They heard a great deal of nonsense about the difference between high pressure and low pressure in electricity. Let him point out that the electricity consumed in lamps in their houses and places of business was always under low pressure, and it mattered not whether high tension machines or from batteries it was the same thing, but if they used low pressure their mains must be enormous. This was a subject he had to consider before his mind was made up many years ago as to what would be the best system to adopt for light, and he found that using the low pressure system, if they wanted to light in a densely populated part of any town a quarter of a mile from the station, they would require 25 square inches of copper to carry the current, and the cost would be utterly prohibitive. If they wished to minimise the size of their copper they had to adopt the course which he believed Mr. Shoolbred had advocated there. They must put about the town a large number of small stations, so that their current should never have to travel from each station to do its work. He understood it was proposed by a learned Alderman of the borough that they should work stations which should each be capable of lighting 2,000 lights. If the Corporation of Brighton had to undertake the lighting of Brighton it must do it thoroughly. Brighton required 80,000 lights, at least, before it could be said to be lit by electricity. On the system proposed Brighton must have 37 to 40 stations, with an electrical expert at each station. He would ask whether they believed a gas company would thrive if Brighton were lighted by 37 to 40 little gas stations. How could any industry thrive under such circumstances? Could 30 or 40 little breweries make their product at the same cost as one large brewery capable of turning out the same amount? It was absolute nonsense to consider the storage multiplication of small stations. Not only was there the cost of the small stations, and skilled superintendents at each, but they had to have small engines and reserve at each station. He thought the proposal was that there should be two engines running at each of these small stations, and one in reserve. That was to say, one-third of the power of each station must be held in reserve. In lighting from one station a sixth of their power for reserve was ample, and this would make a great deal of difference in their expenses. It was pointed out that having those small stations all over Brighton they would be obliged to use gas engines. Take the other side of the picture: If they used the high pressure they would have one station in Brighton. Instead of having 40 stations with three engines in each, or 120 in all, they would have one station with about eight engines in work and two in reserve, each engine, at least, lighting 10,000 lights. In London they put one pair of engines to light 200,000 lights, and he thought in a place like Brighton it might be advisable to adopt even a larger unit than he had suggested. Then these small gas engines were not economical. He thought the estimate in Crossley's book was that the gas cost, to drive the engines, 1d. per horse-power an hour. With the most economical engines of the day the quantity of coal consumed to give one horse-power was 1½ lb., but take it as 2 lbs. costing ¼d. as compared with the 1d. per hour of gas. But from what he had heard from friends who used gas engines, they had found that the makers' estimate of the cost of running was below the mark they had been doing it at, but that it was nearly double. If it were the fact that gas engines were a proper means of creating power to be used for general commercial purposes, why should not these factories run with gas engines, especially at places like Leeds, Newcastle, and Manchester, where the gas was under 2s. per 1,000 cubic feet? There the factories were practically, without exception, worked by steam. This alone must be a conclusive argument.

Now, which was the best to use—batteries or a reserve power? Secondary batteries were very costly, because when they filled them with electricity, in the discharge they lost about 40 per cent., so that they had to manufacture 40 per cent. more current than reached the consumers. That alone was a very serious loss. Supposing any one of them carried on a business as a coal or corn merchant, and sent out their coal or flour in sacks that leaked to such an extent that for every hundredweight they sent out they could only deliver 40 per cent. short at their customers' places, how could a commercial business thrive under such circumstances? That was not all. The makers of the batteries said they could be maintained at a depreciation of 12 per cent. That might be so; but a friend of his there lit his mansion by accumulators, and at the end of three years, out of some 50 cells, 11 had already been renewed, and the whole of the cells appeared to be in such a condition as to necessitate renewal. He then thought he would send for the storage people themselves, and he got them to send and make a report. They at once also immediately condemned the batteries, and sent in an estimate which amounted to twice as much as he had anticipated for putting new batteries in. He might mention another case of a friend who had had his mansion lighted by storage batteries for the last eight years, and he had told him that he had just worn out his second set. The experience he had had showed him that the depreciation was very much nearer 25 to 30 per cent. He accidentally heard that day that at some public installation near Brighton, at Haywards Heath, where they had been lighting by accumulators, their batteries wanted renewing in less than three years. It had been said that transformers by which the high pressure was reduced to low pressure were dangerous to life and complicated. As to the danger to life, he did not know where it could exist, because they could sit on the transformer, they might hold any part of it, and in any way handle it, and it was impossible with the transformer to get a shock from it. Therefore he could not understand the element of danger which was supposed to exist. So far as the idea that the transformer was a complicated piece of mechanism was concerned, it was simply absurd, because the transformer consisted of only two wires side by side in a piece of wire doubled over them, and he did not know anything much simpler.

He understood the largest consumer of the electric light in Brighton was determined, in consequence of the fear that one company might give up and that the Corporation might take the lighting into their own hands, had determined at once to put down its own plant and do its own lighting. He happened to know that, as one of the directors of the Grand Hotel told him that they had had a meeting of the board and that this course was decided on. In conclusion he would beg of them before they thought of going into any battery system to consult experts of the highest order. Let them consult such a man as Sir William Thomson, a man who was competent to give an opinion, and whose opinion would carry absolute weight, because those to whom it would go knew that they could rely on him. But the Council had only to spend the £30,000 in the way suggested, and he would guarantee that every farthing was lost to the ratepayers. One station with reserve power was absolutely safe in collieries ventilated by fans by engines with reserve. Let him answer one other argument that might be raised by those who propose to use accumulators. They said the steam engine was most economical when seen at full load, and they should use small engines running at full load to charge accumulators, and so get the most economical results. This was throwing dust in their eyes. Supposing they were lighting from one station with ten engines there was an instrument in the room that showed the exact number of lights burning. The moment the engineer found there was not enough work to keep one of his engines running, he stopped it and kept the remainder efficient, and the system was altogether as efficient as the other, but as regarded the cost there was no comparison.

Electric Lighting at Weybridge.—Last week the electric light was used here for the first time, and the results spoke well for the installation, which has been laid down by the Laing, Wharton and Down Electric Construction Syndicate. Several of the residents have visited the works and profess themselves favourably impressed. The work is nearly completed and will after the arrival of some daily expected fittings, be completed within a week.

THE BROOKLYN SUBWAYS.*

FINAL REPORT OF THE COMMISSION—INTERESTING REVIEW OF THE UNDERGROUND AND OTHER WIRE WORK IN BROOKLYN.

(*Continued from page* 163.)

The distance at which induction, if not remedied in some way, may cause a perceptible disturbance, is not well settled; but there is no doubt that it is greater than the average width of a street. The Edison system of telegraphing to and from moving trains, reported to be now in use on the Lehigh Valley Railroad, is an instance. A message sent along the telegraph wires by the side of the railroad, by means of the Morse signals, produced by "making and breaking" the current (that is, by rapid changes of electrical condition) repeats itself by a repetition of such changes upon a closed circuit contained within a car of the moving train, and wholly disconnected from the telegraph line. This smaller circuit of wire includes a telegraph instrument, by means of which the changes of condition are made audible in the usual way, and the message is read. Induction, however, is weakened as the square of the distance increases.

It is not, therefore, the intensity of the inducing current, but its irregularity, which causes induction. And hence the so-called alternating currents, which are reversed with great rapidity many times per second, are the most powerful disturbers of neighbouring wires. The inductive effects of telegraph and telephone wires are lively but weak, and are perceptible on telephone lines only, in the form of cross-talk, or the racket of Morse instruments interfering with the hearing of messengers. Even the induction from alternating currents can be rendered comparatively tolerable by the adoption of the remedies above described.

It is to this phenomenon of induction, presented in a maximum degree by the alternating current, that one of the greatest modern advances in the application of electricity is due; and since the "alternating system" is destined to receive a very wide extension, and to affect in important particulars the municipal problem under discussion, a simple statement of its peculiarities, in popular language, will here be given.

As has been remarked, a given amount of electrical energy may be conveyed by a current, either of small amount and high potential, or of larger amount and lower potential. Now (to confine ourselves for the moment to electric lighting as the use of the energy), it has been shown that the Edison system, for instance, with its low tension current and incandescent lamps, is (when properly installed so as not to be liable to set fire to house interiors) not dangerous to human life. Moreover, it is successfully operated underground, on a system admirably perfect in ingenious device and mechanical execution. The incandescent light is the best indoors; and for ordinary street lighting, it is really the best out-doors. The substitution for the old gas lamps, of incandescent lamps of equal number and say 25 or 30 candle-power, would give a diffused street illumination, free from the black shadows and irritating fluctuation of the arc lights, and certain to be more satisfactory to citizens.

Why, then, should not this system be adopted, and high tension currents excluded altogether? This interesting question involves important commercial interests, but will be frankly and impartially discussed. So far as the public action of the board is concerned, it has been consistently in favour of the Edison system. As compared with any other system now operated in Brooklyn, whether for street lighting or domestic purposes, it is undoubtedly superior; its introduction into the city after a prolonged struggle with adverse interests was a public benefit; and its use in our streets would be another. Nevertheless, the system labours under commercial disadvantages, which make it almost impracticable for the wide distribution of light, and will probably prevent it from becoming the "system of the future," although the incandescent lamp will very likely be the lamp of the future.

The principal disadvantage lies in the fact that the low tension current requires large conductors and expensive machinery, and cannot be operated for more than a mile, at most, from the central station, without such cost in copper, &c., as prohibits its commercial use; whereas high tension currents carrying an equal amount of energy can be generated with cheaper plant, and conveyed by smaller conductors for many miles. Electric arc lights are operated in Brooklyn as much as eight miles from the dynamo.

But some high tension currents can be transformed at any desired point into electrical energy of larger quantity and lower potential, and utilised in that form for incandescent lighting. In other words, the energy packed for cheap transportation in small quantity can be unpacked and expanded; as it were, in order to utilise it in quantity. This is possible with the so-called "alternating" currents, from which, by means of so-called transformers or converters, induced currents may be obtained, representing portions of the total energy of the original current, but in different proportions of the two factors, quantity and intensity. The alternation—*i.e.*, the swift successive reversals—of this current, giving the maximum inductive effect, is what permits "conversion" in this way. A "direct" continuous current produces induction by its fluctuations only, after it has once started; and such fluctuations, kept as small as possible in order to secure uniform work, are too insignificant to be utilised by conversion.

Without describing the details of the converters of the alternating systems, it is sufficient to say here that the main wire, carrying the high tension alternating current, is not tapped by any metallic connection. The coil which receives the less intense current is simply brought near to the main current, and thorough insulation separates the two. No instance has ever come to the knowledge of this board in which the intense current has escaped to the conductor thus brought near to it. Such proximity in a carefully constructed, locked apparatus, accessible to trained experts only, is a very different thing from proximity in the air or in manholes frequented by more or less unskilled workmen.

The cheapness of high tension currents, and the fact that with given conductors already laid, and burdened up to the safe limit of quantity, the only way to increase the delivery of energy is to raise the potential, has led to a constant quiet advance on the part of the electrical arc light companies. Almost without exception they use more intense currents than they profess to use, or formerly did use. An arc light company having a certain number of lamps "in series" (that is, strung together so that the current passes successively through all, losing a number of "volts" of its intensity at each) can only extend that series by increasing the intensity so as to supply additional lamps; and since this requires no additional station plant, the temptation to do it is strong. Increased intensity may also be resorted to for increasing the amount of light at each arc. Consequently, companies which began with 1,500 volts, not infrequently employ 2,000, 2,500 and 3,000.

The "quantity" currents cannot be thus increased in quantity, upon the same conductors. Since the incandescent lamps consume principally quantity of current, they are usually set (in the Edison system) "in multiple arc;" that is to say, a certain portion of the current is switched off at intervals to pass through a group of incandescent lights, after which, in diminished quantity, it joins the main return current. Hence the conductors are made largest nearest the station, and are diminished gradually, for economy, as the current is diminished by the serving of successive groups of lamps. It is not practicable beyond narrow limits to extend the system once planned for a certain area.

The alternating currents, consisting as they do of rapid reversals of current, each of which constitutes a separate shock, are, *at the same potential*, more destructive to life than the direct continuous currents. But the difference is not of much practical importance at a tension of 2,000 or 3,000 volts. Either current under such circumstances is sufficiently fatal. And since the irresistible commercial tendency is towards higher potentials, it will probably be found safer in the end to adopt very high tension, and to use the alternating currents.

For the currents are dangerous either through direct contact with man or beast, or through contact with other conductors which may indirectly lead to the same result. Now, the alternating current may be put underground beyond any risk of the first danger; and the second danger may be entirely confined to the transforming apparatus, accessible to experts only. It is perfectly feasible to distribute electricity in this way from a current of 10,000 volts intensity, carried underground, so that the working currents everywhere used, and the only ones exposed to any chance of accidental contact shall be no more intense than 500, or 100, or 50 volts, according to the work required of them. A main alternating current of 10,000 volts is now carried in this way into London, and reduced to much lower potential (though not so low as the above) for arc lighting.

The economical details of such a scheme have never been perfected. They would be affected by many conditions—among others, the great question, not yet satisfactorily solved, of the duration of underground conductors under high tension. But this much is certain: the earning power of a conductor conveying a very large amount of energy is so much larger that its owners can afford to spend much more to make it perfect and keep it so. Moreover, such a conductor would be buried in a conduit without manholes—or at least without such manholes as are required for connections and joints and the perpetual change of cables, and are therefore frequently opened and entered by common labourers. All the conditions of safety and permanence once found advisable could be vigorously maintained.

There is one drawback to such a scheme. The alternating currents, when "transformed," produce alternating currents only; and these, though they will support both arc and incandescent lights, will not furnish motive power. Attempts to get a direct current out of an alternating one for this purpose have not yet, so far as known to the board, proved entirely successful—although this statement is made with some hesitation, in view of the rapid progress of practical electricians and inventors. But if this has not yet been done, it is almost certain that it will be done. That there is nothing impossible about it is proved by the fact that the dynamo itself generates alternate currents, which are combined into the ordinary direct current by the "commutator." When this transformation shall have been achieved with the induced alternating current, so that from high tension conductors of that class continuous quantity currents of lower tension can be derived for motive power, the advantages of this system will be complete.

The progress of such electrical improvements is both helped and hindered by the competition of patented systems. Discussion of them in the newspapers is usually coloured by commercial interest—each party disparaging the system which it does not own and is not permitted to use. Absolutely fair and thorough competitive tests in practice, and the final combination of the best features of all systems into one best system for each set of conditions will take place only when by commercial consolidations the ownership of essential patents is centralised, or by lapse of time they have become public property. Evidences of the former process are not lacking, and it may at any moment produce important alliances, greatly widening the field of choice as to the details of electrical installations.

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* New York *Electrical Review*.

Such being the actual present and probable future of this problem, the following suggestions are offered as to the legislation best adapted to meet it, especially in this city:

1. Since the space under the streets is limited, the city ought not to surrender it, beyond recovery on reasonable terms, to any private company. For if at last the perfect comprehensive system should be reached (in the direction above indicated or in any other), the city would be most unfortunate if by grants already made its free action in the matter were prevented.

2. The placing of telegraph and telephone wires underground may be continued without fear of interfering with the future comprehensive system; for these wires will never be advantageously included in the same conduit with the other classes, and since they constitute by far the larger present nuisance (and, in the neighbourhood of high-tension currents, indirectly the larger danger also), they ought to be buried as fast as possible.

But this should be done under official control, not limited by law to single, rigid functions, but clothed with full power for the regulation of all overhead as well as underground systems.

3. It is of the highest importance that the city itself should take the lead in this matter by putting its police and fire telegraph lines underground. In those cities outside of Brooklyn, where the largest amount of underground electrical service has been provided, the city has thus set the example. In Brooklyn it has lagged in the rear, and hundreds of poles from which the private wires had been removed, have remained in our streets, as plain a nuisance as before.

4. Either the executive authority, controlling the electrical conductors, should also make contracts for street lighting, or the department making such contracts should act in harmony with it and according to its advice. The plan of contracting for the whole city, or for very large portions of it, with a single company and for a single year, though it may secure a low price, does not promote the progress of improvement and the ultimate selection of the best system. The short contract encourages neither permanent installations nor experiments for better service. The cheapest plant is the best, for one year, and the construction of subways for so short a certainty of use is out of the question.

Probably equally cheap service, with far greater perfection, could be secured by a system of district contracts, under which rival underground systems might compete side by side in adjoining districts—all being under continuous and rigid inspection and held to careful specifications as to quality, uniformity, and safety of service. Such contracts, in order to secure a low price to the city, would have to be for a longer period than one year—say, five years at least; and probably special privileges as to the supplying of private customers through street conduits would have to be added as a final inducement, being carefully guarded. (For the next five years there is little danger of extortionate charges for domestic lights. The electrical companies are competing with gas, and can only get that business by bidding as low as possible.) At the end of the period of contract the city should be free to act as might seem wise—either abolishing, modifying, or continuing the district system, and selecting for further service those methods which had proved best in practice. The control of the street space and the ownership of the conduits should revert to the city on equitable terms stated in the contracts.

A plan of this general nature would involve a monopoly, it is true; but it would be limited in area and time, and under close supervision. On the other hand, such a plan would put rival systems into intense competition as to excellence of service, and would constitute a conclusive test, in which every citizen would take part. Moreover, it would hasten the solution of the remaining difficulties of the subject by the most capable—almost the *only* capable—persons. For the best practical electricians are unquestionable in the service of the electrical companies. If it can be made the interest of these companies, not by unreasonable threats, but by fair business inducements, to operate underground, they will find ways and means of doing so, sooner than anyone else.

5. Whether any such plan be followed or not, the details of electric light installation should be subject to inspection and summary control by some authority outside of the companies themselves. The inspection exercised by the underwriters furnishes a simple model. No arbitrary order could command more prompt obedience than does the simple notification of an insurance inspector that unless a certain danger be removed, insurance will be voided; and a provision of law, subjecting electrical companies to exemplary damages in every case where notice of a dangerous defect, given by the electrical inspector, had been disregarded, would probably be effective. But the proper authority should also have power of summary action, in case of such disregard.

By order of the board.

(Signed) G. W. PLYMPTON, *President*.

APPENDIX.

In addition to the above report of the board there are several additional reports from the officers of the companies operating electric lines in Brooklyn. The report of the superintendent of the Western Union Telegraph Company states that his company operates lines distributed as follows:—

	Feet.	Conductors.	Miles of Conductors.
On elevator railroad	3,700	19	13·3
On poles	52	29	·30
"	20,340	12	46·35
In N.Y. and N.J. Telephone Subways	5,810	19	20·72
In N.Y. and N.J. Telephone Subways	2,293	10	4·34
In N.Y. and N.J. Telephone Subways	3,933	37	27·56
Total	36,128	...	112·58

The report of General Manager Sergeant, of the N.Y. and N.J. Telephone Company, shows the condition of line work in his company to November 1st, 1889, in the following table:—

	Miles.	Miles.
Length of conduit, November 1st, 1889 ...	...	16·722
Length of duct, November 1st, 1889 ...	...	106·149
Length of cable underground, November 1st, 1889	24·976	
Length of cable elevated R. R., November 1st, 1889	14·760	39·736
Length of conductors underground, November 1st, 1889	2954·875	
Length of conductors elevated R. R., November 1st, 1889	1399·482	4354·357
Number of subscribers working through underground and elevated R. R. cable ...	...	2,718
Aerial wires removed, December 1st, 1888, to November 1st, 1889	...	411
Poles removed, December 1st, 1888, to November, 1st, 1889...	...	71 poles.
Poles from which telephone wires have been removed but which remain for city use ...	...	271 poles.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"The Theory of Armature Reactions in Dynamos and Motors," by JAMES SWINBURNE.*

It seems to be generally supposed that electrical engineers are in full possession of means for calculating out and designing a dynamo or motor. This is no doubt the case as regards very small machines, and as regards large machines when considered with reference to no load. The effect of the armature current is mentioned in the classical paper of Drs. J. and E. Hopkinson, the excitation necessary at full load being given in terms of the armature current turns and the lead of the brushes; but as the lead of the brushes is determined after the machine is made, that paper gives the first step towards a solution of the armature reaction, but does not go farther. As not only the excitation necessary at full load, but also the best dimensions of the magnets and the proper shape of the pole-pieces, depend on the armature reactions, and as the armature reactions are of immense importance in large machines, such machines cannot be designed with accuracy unless the armature reactions and position of the brushes at full load can be foretold. The armature reactions are often regarded as obscure and unimportant phenomena, but, except in very small dynamos, the error due to neglecting them would be much greater than that due to neglecting the waste field, which has, of late, received so much more attention.

As most engineers are now in the habit of using C.G.S. measure, the C.G.S. system will be used in this paper. The only new importation into dynamo work will be the idea of magnetic potential, as it is exceedingly convenient for explanation. The magnetic potential is, of course, the line integral of the magnetic force, and is 4π times the current turns. As it is cyclic, we must take the line integral once round a circuit interlinked with the exciting circuit. Any point of the circuit may be assumed as of zero magnetic potential, but generally difference of potential is alone considered. The magnetic potential may be thought of as ampere turns, or might be measured in ampere turns; but as such a method is unusual, it will be taken in C.G.S. measure, being denoted by the symbol Ω; and for want of a unit of its own, it may be measured in ergs. An ampere turn thus gives a magnetic potential of $4\pi/10$ ergs, or 1·26 ergs.

MAGNETS AND WINDING.

As single magnet machines are very largely used now, and a type can be taken which is approximately that used by most of the large representative makers, such a machine may be taken as an example. A formula which gives the size of iron, and the excitation needed, will then be worked out.

The vertical line through the centre may be taken as at zero magnetic potential at no load. Assuming the length of the core to be the same as that of the pole pieces, and calling the external radius of the core r, and radial depth of the discs b, and the length of core a, and the armature induction B_a, the surface integral of the induction, or what may be for shortness called the total armature induction, is $2\,a\,b\,\mathrm{B}_a$. The desired armature induction is here assumed. In practice, different makers prefer different inductions, and to discuss the various considerations would take too much room, and would be outside the subject of this paper. The distance, l_a, which represents the length of iron that has to be magnetised to the induction B_a depends on the arc of embrace of the pole pieces; but a large error in the estimate of this length causes a very small error in the design of the machine, as very little of the excitation is spent on this part of the magnetic circuit. The fall of magnetic potential over $\frac{1}{2}\,l_a$ is $\frac{1}{2}\,l_a\,\mathrm{B}_a/\mu$, and may be written $\frac{1}{2}\,\Omega_a$. The induction in the air gap depends on the armature induction, the radial depth of the discs, and the pole face angle. It will be written B_g. The line integral of the induction across the gap is $\frac{1}{2}g\,\mathrm{B}_g$, where g is the distance across the gaps. $\frac{1}{2}g\,\mathrm{B}_g$ may be written $\frac{1}{2}\,\Omega_g$. The fall of potential from the middle of the yoke to the pole piece depends on the length of the circuit and the induction. It may be written $\frac{1}{2}\,l_m\,\mathrm{B}_m/\mu$, or $\frac{1}{2}\,\Omega_m$. The induction that can best be used in the field magnets depends, again, on many things that cannot be discussed shortly. As it is generally best to use a lower induction in the yoke, that must, of course, be taken into account. As the other half of the magnetic circuit is similar at no load, the line integral of the magnetic force needed in the shunt is $\Omega_s = \Omega_a + \Omega_g + \Omega_m$. As to the length of the field magnets, it depends on the total excitation needed. Different makers allow different lengths per thousand ampere turns on the fields.

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* Announced for reading last night.

At full load the armature induction has to be increased to allow for the resistance of the armature and series coils, and sometimes for the leads also. A higher value is therefore taken for B_a, and therefore for Ω_a. The effect of the armature current itself may be divided into two components; and in the case of a drum armature, which may be taken for the sake of simplicity, the electrical effect is the same as if the external conductors were connected across the ends as shown in fig. 1. There is thus a belt of current turns opposing the field excitation, and another belt acting at right angles to it. These may be called the back and the cross ampère-turns, and the induction produced by them, the back and the cross induction respectively. The breadth of these belts, or the number of turns in each, depends on the lead of the brushes. For the present the lead of the brushes may be assumed. The extra difference of magnetic potential between the pole pieces due to the back current turns is $\pi\,\mathrm{C}\,n_b/10$, where C is the armature current in ampères, and n_b the number of external armature conductors in the belt of back turns, n_a being the number of external armature conductors. This may be written,

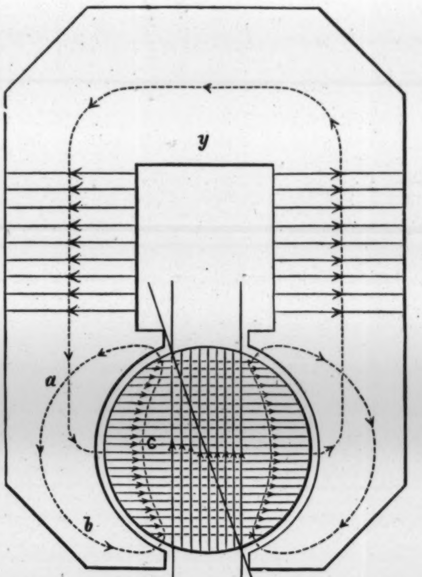

FIG. 1.

$$\Omega_b = \pi\,\mathrm{C}\,n_b/10. \qquad (1)$$

The difference of potential of the pole pieces at full load is thus $\Omega_a + \Omega_b + \Omega_g$; and Ω_a and Ω_g are greater than at no load, because the armature and gap induction are higher. The difference of potential between the pole pieces may be shortly written, Ω_p. In a given type of dynamo the percentage of waste field varies directly as the difference of potential of the pole pieces, provided the field magnets are not strongly magnetised, and is independent of the linear dimensions. The actual waste field, however, varies directly as the difference of magnetic potential between the pole pieces, and directly as the linear dimensions, or as the diameter of the armatnre. If the armature cross sectional area is $2\,a\,b$, and the armature induction is B_a, and if the field induction desired is B_m, the cross section of the field magnets must be

$$\mathrm{A}_m = 2\,a\,b\,\frac{\mathrm{B}_a}{\mathrm{B}_m} + \frac{r\,\Omega_p}{\mathrm{M}\,\mathrm{B}_m} \qquad (2)$$

where M is a coefficient depending on the type of the machine. This coefficient can be readily determined from another machine of the same type but of different size, and an error in its estimation makes comparatively little difference in the dynamo.

In ordinary single magnet machines M is generally about ·08 to ·085; in double magnet machines it is less. Of course a great deal depends on the mounting of the dynamo. A machine let into a bed-plate, as is often necessary in the case of direct-coupled engines has more leakage.

An equation for the shunt and series excitation is now to be found. From (1) the field induction is found—

$$\mathrm{B}_m = \frac{2\,a\,b\,\mathrm{B}_a}{\mathrm{A}_m} + \frac{r\,\Omega_p}{\mathrm{M}\,\mathrm{A}_m} \qquad (3)$$

Giving the value of B_a and Ω_p at no load, the value of B_m at no load is obtained. The shunt excitation is thus

$$\Omega_s = l_a\,\mathrm{B}_a/\mu_a + g\,\mathrm{B}_g + l_m\,\mathrm{B}_m/\mu_m \qquad (4)$$

in ergs, or this number divided by 1·26 in ampère turns. By giving the full load values of B_a and Ω_p the total excitation,

$$\Omega_{\,+m} = l_a\,\mathrm{B}_a/\bar{\mu}_a + \pi\,\mathrm{C}\,n_b/10 + g\,\mathrm{B}_g + l_m\,\mathrm{B}_m/\mu \qquad (5)$$

is obtained, and, of course, the difference gives the series excitation. Of course the full load field induction has already been assumed in finding the size of the magnets.

It must not be forgotten that all this time it has been assumed that the lead of the brushes, and therefore Ω_b is known.

Returning to fig. 1, a closed line, $a\,b\,c$, may be drawn which is interlinked with all the armature conductors under the pole piece. The magnetic potential round this circuit is

$$\Omega_e = \theta\,n\,\mathrm{C}/10 \qquad (6)$$

where n is the number of armature conductors, and C is the armature current as before, and θ is the angle of embrace of the pole piece. As the permeability of the iron, both in the part of the armature and of the pole piece through which this line passes, is great, the whole difference of potential may be taken as being between the core and pole piece. The induction under the leading corner, due to cross current turns only, is then $-\frac{n\,\mathrm{C}\,\theta}{2\,g \times 10}$, and under the trailing corner it is $+\frac{n\,\mathrm{C}\,\theta}{2\,g \times 10}$. The field is thus weakened under one corner, and, provided the permeability of the iron is practically infinite, equally strengthened under the other, being at its normal value half-way down. The cross induction has in this case no direct effect in increasing or lessening the E.M.F. of the machine. If a dynamo were enlarged to scale, the field excitation would increase as the linear dimensions, but the armature current turns, assuming the same current density, would increase as the square of the linear dimensions. If the electromotive force of the machine were kept the same, they would increase faster, as the insulation would take proportionally less room. It is thus evident that a size would soon be reached when the cross induction under the leading corner would be equal to the normal induction due to the field excitation, and there would be no field to reverse the current in the section being commutated. The size at which this takes place varies according to the practice of makers, and is generally above the sizes in common use, as the output of a given armature is generally much smaller than might be taken from it. Machines with single magnets, and fairly large outputs for the size of their armatures, become difficult to design when they have armatures above 35 to 40 cm. diameter. The fault can to some extent be corrected in single magnet machines by making the polar angle—that is, the area of the pole face—small. There are then fewer cross current turns, and the induction in the gap is greater. so there is less chance of reversal of induction under the leading corners. This demands more field excitation and larger field magnets, as the difference of magnetic potential between the poles is greater, and so the waste field is greater. If the pole pieces are made small, so as just to carry the induction due to the field coils without saturation, one side will be to some extent saturated by the additional induction due to the cross current turns. In fig. 2 the pole piece is small across $a - b$, and the iron may need some magnetic force there, so the whole of the magnetic force of the cross current turns will not be spent on the gaps, and the cross induction will thus be less. On the other side, of course, the cross induction is not lessened, as the iron is less magnetised. The resulting field will not be symmetrical. If the armature is Gramme wound, the lower brush will need more lead than the upper. Sparking at the lower brush in single magnet Gramme machines has been frequently noticed by dynamo makers. Of course it may be partly due to the poles being too small in section, so as to throttle the main induction of the field magnets, but it is much more often caused by the cross induction. If the armature is drum-wound, throttling the cross induction on one side will do some good in lessening the cross induction; but it is difficult to throttle the cross induction without also throttling the field induction proper, and wasting field exciting power.

Fig. 2 may be taken as a diagram of a 30-cm. or 12-inch armature machine of about the usual type, with the magnets rather close.

If there were no cross induction the pole pieces would not be strongly magnetised anywhere; but when the cross induction is superimposed, the neck reaches a high magnetisation, the induction in this case amounting to about $B = 15{,}800$ there, and to about $B = 17{,}200$ a little higher up. If it were not that the cross induction is lessened by the saturation of the iron, the neck would rise to $B = 17{,}500$, and in the region 5 cm. or so above the centre line to $B = 18{,}600$. The difference of magnetic potential between a point a little below the middle and the top of the pole piece comes to about 1,880 ergs. The effect of this is that more than 1,000 extra ampère turns are required on the field magnets. In a Gramme machine the effect is very easily observed by the use of a pilot brush. A resistance of, say, 100 ohms is connected between the terminals of the machine. The pilot brush is connected to one terminal of a detector, and the other terminal is connected successively to points in the resistance corresponding, say, to 95, 90, 85 ohms, and so on. The positions of the brush for the zero readings are noted. This avoids errors due to slight variations of speed, which give trouble in the first instance, and errors due to bad contacts. With a drum this method does not give the distribution of the field, as each convolution is on both sides of the armature; but if one pole piece is highly magnetised by the cross induction, the half of the armature under the upper left and lower right hand halves of the pole pieces (in fig. 2) gives a lower electromotive force than the other. This effect is sometimes very marked in machines with cast iron pole pieces.

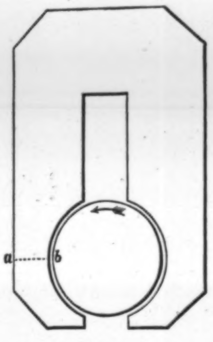

FIG. 2.

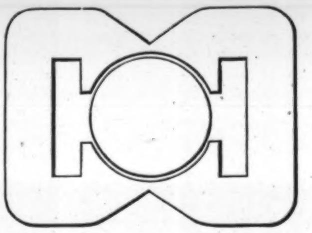

FIG. 3.

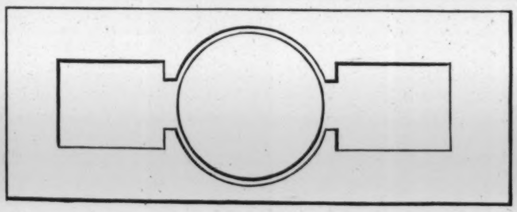

FIG. 4.

A double magnet two pole machine can be made up to a larger size than a single by shaping the pole pieces so as to throttle the cross induction. Two common types of machine are shown in figs. 3 and 4 with the pole pieces so cut. If it be assumed for the moment that the armature section current can be reversed with no appreciable field, the largest pole angle that can be used is when the gap induction due to the field excitation is equal and opposite to the cross induction under the leading corner; that is, when

$$\theta = 2\sqrt{\frac{b\ g\ B_a \times 10}{n\ C\ (r + \frac{1}{4} g)}} \qquad (7)$$

As the armature sections need a sensible field to reverse them, the pole angle must be less than this.

REVERSAL OF THE SECTIONS UNDER THE BRUSHES.

As a convolution passes under a brush its current falls from the normal to zero, and then rises to the normal in the other direction, and the brush leaves the commutator strip just at that instant, else there would be sparking. To find what field the convolution must be passing through to produce this result, the variation of the number of lines of induction through the convolution must be found, and the time of short-circuiting known. Any lines of induction through the convolution must pass; first, round by the field magnets, thus taking the same course as the field magnet induction; 2nd, through the armature and air gap in the same way as the field induction, and then from pole to pole across the external air like the field leakage; 3rd, through the iron of the armature in the immediate vicinity of the conductor, and round the conductor by the air. Fig. 5. In a Gramme armature there are two more paths—4, like 3, only inside the armature ring, and 5, round the ring. The last is neutralised by the reversal of the opposite section, and if an uneven number of sections were used the closed armature circuit would damp it. As to the first, any variation of the induction of the field magnets would be damped by the closed copper field magnet coils, not to speak of the closed armature coils forming the belt of back ampere turns. In addition to this, if the current died away, and increased up to its normal in the opposite direction uniformly, the current turns linked with the circuits 1 and 2 would remain constant, for on one side there is a constant increase of back current turns, and on the other the reversed or forward turns are again crossing the lines 1 and 2. There could thus only be variation of induction round circuits 1 and 2 if the current in the section did not change uniformly. Any change in the induction round such a circuit as 2 would be damped by the Foucault currents produced in the pole pieces, as the current is small and the frequency enormous.

The third course—3—may be treated as if the convolution were stretched out straight in air. The self induction could then be calculated. As half the circuit round the wire is through iron, the self induction may be doubled. The conductor may be taken as a linear conductor, and the self induction of the active part taken within reasonable limits. To give some idea of the magnitudes dealt with, we may take, as an example, a drum armature of 15 cm. radius and 38 cm. length, with 120 external conductors, giving 100 volts and 400 amperes at 800 revolutions per minute, The self induction of the active part may then be taken from 0·5 to, say, 5 cm. radius. Then

$$L = 38 \int_{0\cdot5}^{5} \frac{4\ d\ r}{r} \times 10^{-9} = 350 \times 10^{-9}.$$

In a drum machine the neighbouring conductors belong to different convolutions, and in this case both are being commutated at the same time: the mutual induction of the convolutions must therefore be taken into account. To calculate the coefficient of mutual induction would involve the calculation of the mean geometrical distance. It will be near enough for the present purpose if the mutual induction is taken at

$$M = 38 \int_{1}^{5} \frac{4\ d\ r}{r} \times 10^{-9} = 244 \times 10^{-9}.$$

The active part of the convolution may therefore be taken as having a self-induction of 594×10^{-9}. It is more difficult to get an idea of the self-induction of the end plates. The end plates are flat copper, probably 3 cm. or so wide; they are not close to the iron of the armature, bnt are among other plates, which lessen the effect. Probably $L_2 = 24 \times 10^{-9}$ for each end will be nearly correct. The coefficient of self-induction of a convolution is thus 1,236. The resistance of the convolution is ·000456 ohm. If the brush covers one section and a half, the time of short-circuiting is ·001875. From these data the electromotive force necessary to bring the current to 200 ampères can be determined—

$$E = \frac{C\ R\ \epsilon^{-\frac{R\ T}{L}}}{1 - \epsilon^{-\frac{R\ T}{L}}} + \frac{C\ R}{1 - \epsilon^{-\frac{R\ T}{L}}} = \cdot274 \text{ volt.}$$

As the velocity of the conductor is 527 cm. per second, and iss active part is 76·2 cm., the field needed to reverse is $B_g = 685$.

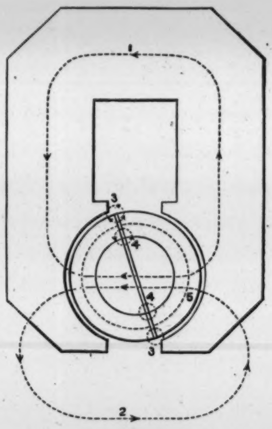

FIG. 5.

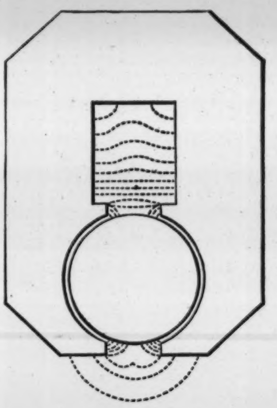

FIG. 6.

It must be borne in mind that this calculation is at best only a rough approximation. In the first place the field is not really uniform. In the second, the convolution has not really a constant coefficient of self-induction, as that depends on the position of the active part of the conductor in the field, and on the megnetisation of the iron in the armature in its immediate neighbourhood.

If the machine were made with two convolutions per section, and if the brushes still covered one section, it is obvious from the formula that the field necessary to reverse would be twice what it was before, if the self-induction is four times. As a matter of fact, the self-induction would not be nearly four times, for the conductors are too far apart. It would be somewhere between twice and four times.

If there were no self-induction the field necessary to reverse would be just enough to preserve a current of 200 ampères against the resistance of the convolution. If the brush surface were the same the convolution would be short-circuited for, say, $\frac{1}{40}$th of a revolution. The loss of power would then be 28 watts. The self-induction prevents the current reversing instantaneously, and makes it change gradually. This reduces the power to about one-third, so 18 watts is about the loss of power due to the short circuiting of the convolution. The self induction of the section is thus instrumental in preventing waste of power.

The field necessary for the reversal of the current in a section being known, the position of the brushes can be determined.

If the armature had no current the field would fall off very quickly round the armature after emerging from under the pole pieces. At no load, for instance, the disposition of the lines of induction is, roughly, as shown in fig. 6. In this case the lines that enter the armature are all cramped together at the pole corners. The lines leaving the shanks of the magnets pass right across and do not enter the armature at all.

If the cross current turns are alone considered, a disposition, roughly, as shown in fig. 7 is obtained. There are no lines across, so the lines are cramped together, where they leave the armature only. If figs. 6 and 7 were superposed, the opposite inductions would be equal quite close to the leading pole corners. The exact position would be difficult to determine, but by such a rough method as that just described the position can be found so as to make no sensible error in the calculations. Fig. 8 shows the disposition of the induction due to the back current turns. Those going right round the field are left out, for their disposition is almost exactly the same as that of the field lines, and they are cancelled by some of the series winding. If fig. 8 is superposed on figs. 6 or 7, the induction is increased on one side and decreased on the other. On each side of the centre line the addition or subtraction is uniform. It is clear, then, that except in the case of very small machines, or machines with very light loads, the position of non-sparking of the brushes is close under the leading pole corners. In practice, this is easily verified by taking two pilot brushes and a detector, and finding the position of no deflection when one is slightly in advance of the other.

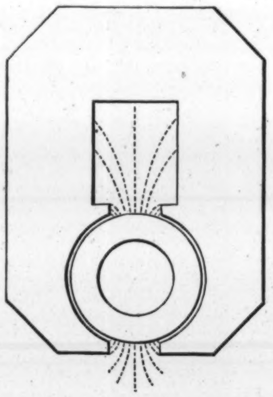

FIG. 7.

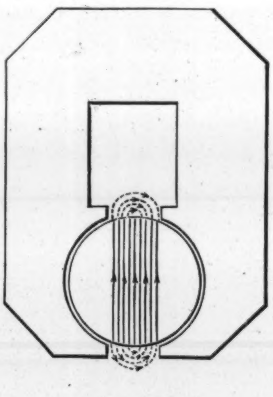

FIG. 8.

A glance at actual machines shows that the conclusion here arrived at theoretically—that the brushes are almost under the leading pole corners—is correct. The angle of lead of brushes at full load thus depends on the pole angle, and the back potential, Ω_b, can now be given in the form $(\pi - \theta)\, n\, \mathrm{C}/10$.

Equation (5), for the full load excitation, can therefore be written,

$$\Omega_{s-m} = l_a\, \mathrm{B}_a/\mu_a + (\pi - \theta)\, n\, \mathrm{C}/10 + g\, \mathrm{B}_g + l_m\, \mathrm{B}_m/\mu_m \qquad (8)$$

Equation (2), for the cross sectional area of the field magnets, also becomes, in full,

$$\mathrm{A}_m = 2\, a\, b\, \frac{\mathrm{B}_a}{\mathrm{B}_m} + r\, \frac{l\, \mathrm{B}_a/\mu_a + g\, \mathrm{B}_g + (\pi - \theta)\, n\, \mathrm{C}/10}{\mathrm{M}\, \mathrm{B}_m} \qquad (9)$$

Probably the greatest problem that still remains to dynamo makers to grapple with is that of lessening or avoiding sparking at the brushes. At present it is necessary to move them whenever the load of the machine is altered. Several methods of moving the brushes automatically have been proposed, and perhaps used, in the United States, but they have not come into common use in this country. An attendant is therefore necessary if the brushes are to be kept in good order. Fig. 9 shows a few turns of a winding specially designed to need very little moving of the brushes. A convolution, instead of being wound over the armature diametrically as usual, is wound over the core so that one side of it gets into the field just as the other side is coming out. At no load the convolution is commutated when the sides are at equal distances from the pole pieces. At full load a very small movement of the brushes is enough to bring one side out of the field and put the other side in far enough to reverse the current. If the brushes are not shifted, the conductors in the belt between the pole pieces have current in alternate directions, so that they do not act as the coils of an electro-magnet; the cross induction just under the pole corners is, however, the same. As the lead of the brushes is very small, the back current turns are small also. As the change of field is rapid, it is necessary to use very narrow brushes at light loads, while there is sparking if there is the least inaccuracy. This winding is not perfectly suitable for very large machines with single magnets, for one conductor has its current reversed by the top leading pole corner, and the other by the lower one, and, as already explained, the top is generally stronger, so that more lead is needed on the bottom brush, and this is troublesome. In small machines this does not take place to the same extent.

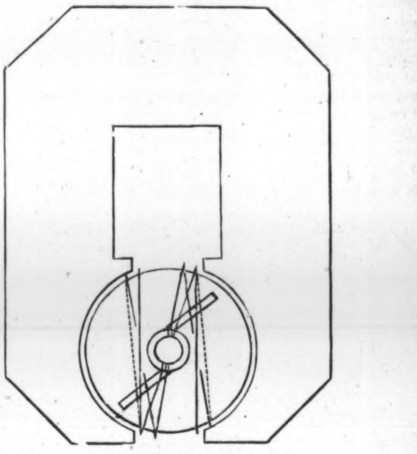

FIG. 9.

(To be continued.)

Physical Society, Annual General Meeting, February 7th, 1890.

Prof. REINOLD, F.R.S., President, in the chair.

The reports of the Council and of the treasurer were read and adopted. The former stated that there had been a very satisfactory increase in the number of members during the year. The number now exceeds 360, of whom 80 are Fellows of the Royal Society. During the year the Council had proposed to change the time of meeting of the Society from Saturday afternoon to Friday evening. The change was adopted by the members by a vote of 129 to 30 and had resulted in a larger attendance at the meetings. During the year, the second volume of the translations of important foreign memoirs had been issued to the members, and it was hoped that a third volume would be published early in the present session. The Council had to regret the loss, by death, of three well-known members, James P. Joule, Warren de la Rue and Father Perry. A valuable collection of books had been given the Society by the Royal Astronomical Society. From the treasurer's report it appeared that the balance of the Society had been increased by £120 during the year. Prof. Hittorf, of Münster, was, at the recommendation of the Council, elected an honorary member of the Society. The result of the new election of officers was declared as follows: *President*, Prof. W. E. Ayrton, F.R.S.; *Vice-Presidents*, Dr. E. Atkinson, Walter Baily, M.A., Shelford Bidwell, F.R.S. and Prof. S. P. Thompson, D.Sc.; *Secretaries*, Prof. J. Perry and T. H. Blakesley, M.A., M.I.C.E.; *Treasurer*, Prof. A. W. Rücker, F.R.S.; *Demonstrator*, C. V. Boys, F.R.S.; *other Members of Council*, W. H. Coffin, Sir John Conroy, Bart., M.A., Conrad W. Cooke, Major-General Festing, F.R.S., Prof. J. V. Jones, M.A., Prof. O. Lodge, D.Sc., F.R.S., Prof. W. Ramsay, Ph.D., F.R.S., W. N. Shaw, M.A., H. Tomlinson, B.A., F.R.S., and G. M. Whipple, D.Sc. Votes of thanks were then passed (1) to the Lords of the Committee of the Council on Education for the use of the room in which the Society met, (2) to the auditors, Prof. Minchin and Dr. Fison, (3) to the President and Officers of the Society for their services during the year. The meeting was then resolved into an ordinary science meeting. Messrs. E. W. Smith and E. Holland, B.A. were elected members of the Society, and Mr. Sidney Evershed was proposed as a member. The paper on "Galvanometers," by Prof. W. E. Ayrton, F.R.S., Mr. T. Mather and Dr. W. E. Sumpner was then resumed by Prof. Ayrton. A long table of numbers accompanying the paper, and representing the result of experiments on many galvanometers, was explained. From this it appeared that galvanometers of the D'Arsonval type were exceedingly efficient in proportion to the amount of wire used in the coils. It was for this reason that voltmeters with strong permanent magnets could be made sensitive even with an exceedingly large external resistance in series so as to diminish the power absorbed by the instrument. The space occupied by the wire was so exceedingly valuable that the extra resistance did not too much diminish the sensibility. The most sensitive galvanometers should therefore be made of the permanent magnet type. If, however, the magnets were to form part of the moving system, as in most galvanometers, the experiments showed that instruments of the Rayleigh, Gray or Rosenthal type were the best. The coils should be numerous and small as Mr. Boys had previously shown. As an astatic system of needles sets itself perpendicular to the earth's field it was recommended that astatic galvanometers should be placed so that the needles pointed east and west. The controlling magnet would then not need to be turned round as it was raised or lowered. It was recommended to calibrate low resistance ballistic galvanometers for quantity by measuring the deflection for a known current. This obviates the necessity for large condensers or high potentials. The method, although not new, is not described in text books. In conclusion, Prof. Ayrton asked for information with regard to microscope galvanometers.

C. V. Boys, F.R.S., thought that the factor of merit of galvanometers should not be given in scale divisions per micro-ampère under the condition of constant controlling moment. This gave too great an advantage to instruments of the Gray or Rosenthal type. Great sensibility could be obtained by diminishing the moment of inertia of the suspended parts, the practical limit being determined by the trouble due to the silk fibre. Spider lines when used in place of silk fibres gave better results. It was possible by using a good suspending arrangement to use needles ⅛th inch long and a period of 20 seconds, and to gain a sensibility far greater than those indicated in the paper. Ballastic galvanometers should be made with needles as light as possible. The method proposed of winding the central part of the coil in the opposite sense to the rest would probably not be good owing to the unevenness of the field produced. The conclusion come to by the authors that D'Arsonval galvanometers of great sensibility should be made with small coils placed in a very strong field was one he had himself come to, but had finally abandoned owing to difficulties caused by diamagnetism in the copper and to excessive damping due to Foucault currents.

Mr. Swinburne thought that the factor of merit of a galvanometer should be determined differently according as it was to be used for the measurement of current, or quantity, or for null methods merely. He saw no great advantage in making practical instruments proportional. The name D'Arsonval should be dropped, as the instrument denoted by it was invented by Varley years ago. He would like to know the relative sensibility of the telephone and the Lippman galvanometer.

Prof. Fitzgerald stated that Lord Rayleigh had shown that the microscope method of observing angular deflections was as sensitive as the ordinary method of mirror and scale, even when only the mirror was used as a pointer, so that if a pointer were attached it would be far more sensitive. The drawback, however, was that it was impossible to distinguish with the microscope between lateral displacements of the needles and the angular motion whose measurement was required. To get over this error it was necessary to read both ends of the pointer, but this was hard to do.

Prof. Ayrton replied to the different points raised in the discussion.

NEW PATENTS—1890.

993. "Improvements in holders for incandescence electric lamps." J. W. Edmundson and W. Clarke. Dated January 20.

1028. "A new or improved method of converting a direct or continuous electric current into an alternating current, and improvements in or relating to apparatus therefor." W. P. Thompson. (Communicated by L. Gutmann, United States.) Dated January 21. (*Complete.*)

1031. "Electric compass and course recorder." J. von Peichl. Dated January 21.

1050. "Improvements in dynamo-electric machines and electric motors." C. Bolle. (Communicated by L. Gutmann, Pennsylvania.) Dated January 21. (*Complete.*)

1068. "Improvements in dynamo or electro-motor conductors." G. B. Luckhoff and E. H. Hungerbuhler. Dated January 21.

1072. "Improvements in electrical switches." G. Binswanger. Dated January 21.

1094. "Improvements relating to secondary or storage batteries." H. H. Lake. (Communicated by T. Ewing, United States.) Dated January 21. (*Complete.*)

1280. "Improvements in switches used for electrical purposes." C. L. Baker. Dated January 24.

1281. "Improvements in secondary batteries." V. H. Ernst. Dated January 24. (*Complete.*) [Date applied for under Patents Act, 1883, Sec. 103, September 28th, 1889, being date of application in the United States.]

1302. "Improvements in means or apparatus for facilitating calculations relating to the supply of electrical energy." A. P. Trotter. Dated January 24.

1347. "An improved fluid for primary batteries." T. Coad. Dated January 25.

1390. "An improvement in connecting wires with attachments for connecting to electric batteries or other firing arrangements." W. Balch. Dated January 27.

1391. "An improved electric firing battery and cells." W. Balch. Dated January 27.

1516. "Improvements in electric light fuses or cut-outs." J. E. Spagnoletti and J. Crookes. Dated January 28.

1554. "An electrical head piece and reins combined, for preventing restive horses and other animals running away." G. Cafiero. Dated January 29.

1596. "Improvements in electric lamps or lighting apparatus." H. H. Lake. (Communicated by F. C. Jenkins, Germany.) Dated January 29.

1619. "Improvements in or pertaining to electric bells or gongs." L. Shilton. Dated January 30.

1638. "Electric automatic railway alarm and signalling device and apparatus." H. M. Harcourt. Dated January 30.

1646. "Improvements in safety devices for electric lines." P. C. Brewster. Dated January 30.

1658. "Improvements in and connected with electricity meters." C. P. Elieson. Dated January 30.

CORRESPONDENCE.

The Belt Fraternity.

Perhaps some of your readers would like to hear of a remarkably sensitive test invented by one of the belt fraternity, which I think must be regarded as one of the greatest marvels, even in these quack days. A poor woman complained of rheumatics in her fingers, when the *doctor* placed a small pocket compass in the palm of her hand, and, passing the belt under it, of course deflected the needle; he thereupon with all gravity informed her that she was certainly suffering from that complaint and offered to supply her with a magnetic wristlet.

It would at first strike one as remarkable that such men could find enough dupes to earn them a livelihood, but when one sees the variety of complaints they assert they can cure we can scarcely wonder; for instance, this same man wanted to sell a woman a magnetic belt which would prevent insanity, that disease having shown itself in the woman's family and having frightened her not a little.

I have reason to believe that our friend is about to take an action for slander against a medical man, and I think we shall all look forward to some disclosures.

Wallace John Sandy.

February 10*th*, 1890.

Coad's Primary Battery.

I wish to notice two or three things in the article contained in your issue of the 31st ult. upon the subject of my battery, and I make no doubt that you will, in common fairness, publish this letter.

You say the commercial success of my battery "will depend upon whether the statement regarding its cost for working can be verified." To meet this objection (which is, of course, a fair one), I some days since gave my formula, which is provisionally protected, and therefore not a secret process, to Prof. Redwood, and his report shall be inserted in your advertisement columns next week.

As regards the "ease in charging and cleaning," I think you ought, in common fairness, to have pointed out the absolute and entire simplicity of the arrangements of the battery, and inasmuch as you do not give your reasons for expressing a doubt, I am entitled to reassert the statements of independent experts consulted, all of whom say that there is really little or nothing in the battery to be affected by the ordinary wear and tear of every day use.

I am glad to find, at any rate, that you, with your enormous experience in matters electrical, and as severe critics, if not opponents, of the "utility of primary batteries," consider that there is only one battery which is the superior of mine.

I am tempted to challenge you to name this superior battery, and at once offer to submit the two to the highest independent authority, and do so with the greatest confidence that, for the purpose for which my battery was designed — namely, miners' safety and portable lamps—there is none superior.

I think you might have done me the justice to say that the question of adapting the battery to other and practical uses is a mere question of mechanical detail and design.

In conclusion, your anecdote of what some people would term a trick practised upon your representative by another exhibitor near the Adelphi you must admit is entirely uncalled for and out of place; whatever opinion you may care to form upon my invention you must, at least, acknowledge that I have courted, if not challenged, a thorough investigation on the part of all persons entitled to be regarded as having a knowledge of the subject.

Theophilus Coad.

Electric Lighting in London.

In Mr. Down's speech at Taunton, as reported in your current number, he says his firm have secured the contract for public and private lighting of half London. I think this will be somewhat new to most of those who have followed the history of electric lighting in the metropolis.

Londoner.

[Possibly the speech was not quite correctly reported Most likely Mr. Down intended to convey to his hearers the fact that his company had secured a portion of the City lighting.—EDS. ELEC. REV.]

Quick Work.

I enclose an account of some quick work in connection with *gas* lighting, which may be as interesting to your readers as the excerpt of last week's issue *re* electric lighting.

R. T. T.

P.S.—*Tit-Bits* office has had the electric light for some time, and I should like to know how many lights were put in on this remarkable occasion.

"Perhaps the quickest piece of work in connection with gas lighting that has ever been accomplished in the old or the new world was last week completed in Balfour Street. On Wednesday evening of last week, says 'The Medium for Puffs,' we sent over to ask if Terivy, of Cockle Swamp, our office boy, would come up and see us, and on his arrival we said to him:—'This room, Terivy, gets so cold with the electric light, that we can't stand it any longer. We wan't to have the electric lamp turned off and the old gas pendant lit by to-morrow evening.' Terivy looked, first, incredulous as to whether we were in earnest; but seeing we were, he reflected for a moment, and then replied, emphatically:—'You shall have it done.' The next evening, at four o'clock, the editorial rooms were lighted by the old gas light, although until the previous day, at six p.m., no one had received any order or instructions in the matter."

Electricity in the Service of Woman.

Many funny stories have at different times found their way into print, *re* electric bell pushes and the queer mistakes made by people who have seen them for the first time. But an incident that happened in this neighbourhood I think fairly "takes the cake." A friend of mine, to the front door of whose house is fitted an electric push, engaged a country girl as servant, when, a few days afterwards, the following conversation took place: "I did have a trouble, ma'am, with the front door bell the day I came. I tried to take hold of it with my nails *to pull it out*, but could not, and so I took my hat off and tried to pull it with my *teeth*, but it would not come out, and so I had to knock the door." I may say she had on an old fashioned poke bonnet, and had to remove it before she could seize the push with her teeth.

F. H. Deeley, *Electrical Engineer.*

February 10*th*, 1890.

Electric Traction by Accumulators.

In the able article on "Electric Traction by Accumulators," in the ELECTRICAL REVIEW on the 7th February, you end up by saying: "The success or failure of electric cars carrying their own motive power depends solely on the cost of accumulator maintenance."

While this statement is absolutely correct, I think it is likely to mislead the uninitiated, especially those who read it in the many other journals which will copy extracts from yours, the bulk of your own readers being more or less well up on the subject.

I think that the statement is misleading, because you do not mention in your article the alternative to the accumulator system. I refer to the direct system, and when it is taken into consideration that in the United States and Canada, where they are years ahead of us in the application of electricity as a tractive power, out of some 1,200 or 1,300 miles of line, either now running or under construction to be run by electricity, only two lines—one twenty miles and the other one mile—have been run on the accumulator principle; and the former has, I believe, now been discontinued. It would almost appear that in attempting to run tramways on the accumulator system in England we are altogether ignoring the experience which has been gained in America, where the direct system has carried everything before it. The Americans state that no accumulator in existence is worth anything for electric traction, except, of course, those who are interested in accumulator patents.

The claim to run at 4½d. per car mile does not show an extraordinary saving as compared with the 4¾d. at which the London Tramways Company works, although I grant that this line runs cheaper than any other horse or steam line in England.

The direct system employed at Blackpool has conclusively proved that a great saving may be made in the working when that system is used, and the reports from the States show that an enormous reduction on the favourable returns from Blackpool can be made; in fact, so great are these savings, that if the direct system was applied in England at within 10 or 20 per cent. of the cost in the States, the result would enable many of the British tramways to earn from 15 to 20 per cent., basing the calculations on existing traffics.

C. H. Wilkinson.

February 10*th*, 1890.

[It is somewhat difficult to grasp the reasons which led our correspondent to pen this letter; our article was confined to traction by accumulators only and therefore could not mislead any one with a less hypercritical nature than Mr. Wilkinson.—EDS. ELEC. REV.]

A Suggestion.

To complete my suggestions, for the present, I shall feel obliged if you will kindly insert in the REVIEW the illustration of the manhole sent you with my letter of the 27th ult.

There may be nothing very special in the design of the manhole, except, perhaps, the brick arch; but as I am not aware of a similar design having been tried, it might interest your readers to observe it.

One Interested.

[We really cannot take up our space with any more of these blocks, which, like Cæsar and Pompey, are very much alike.—EDS. ELEC. REV.]

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Maps of the Borough with copies of the "Form of Proposal" and "Conditions" and of the Draft Provisional Order, together with other information, may be obtained on the personal application of a Representative of any Electric Lighting Company to Mr. J. Henry Taylor, C.E., Borough Surveyor, Barnsley, or to the undersigned.

Proposals, properly sealed and endorsed, must be delivered to the undersigned not later than 10 am. on Friday, the 28th day of February, 1890.

The Town Council do not bind themselves to accept any proposal.

By order, HENRY HORSFIELD, *Town Clerk.*

Church Street, Barnsley,
29th January, 1890.
3585

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T. HORNE REDWOOD, F.C.S., } *Chemists.*

2, FISHER STREET, RED LION SQUARE, W.C.,
London, February 11th, 1890.

I have had submitted to me by Mr. Coad the formula of the exciting fluid which he employs in voltaic batteries. After careful enquiries of manufacturers I am of opinion that buying the chemical ingredients in large quantities the said fluid can be produced at SOMETHING LESS THAN ONE SHILLING PER GALLON.

I have considered the question of utilising the residuum of zinc, and also the recovery of chemicals, and am convinced that a considerable REDUCTION, SAY, 20 PER CENT., may be deducted from the PRIME COST of the fluid on this account.

I have estimated the consumption of zinc in the 12 hours' run of a six-cell battery, and find that it amounts to about two ounces.

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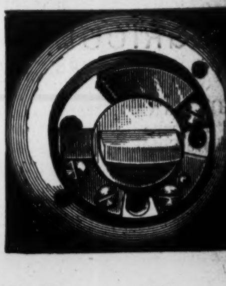

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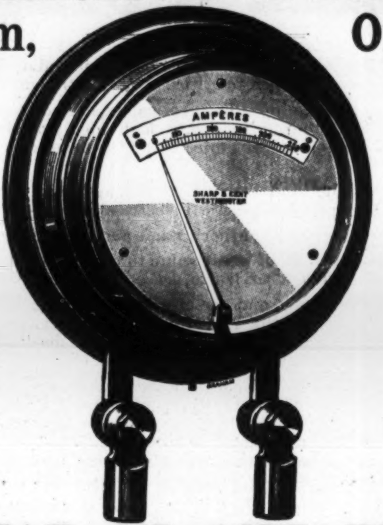

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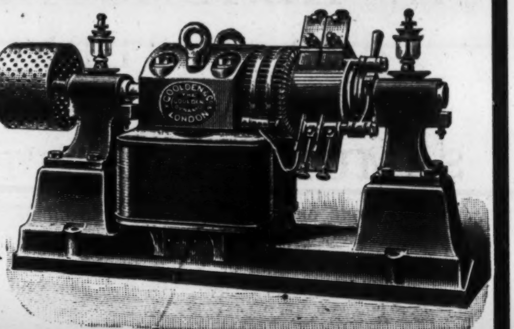

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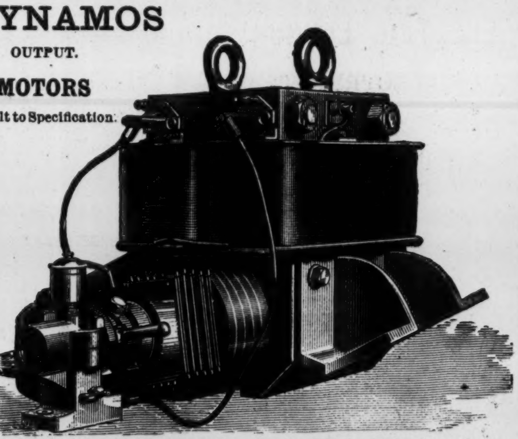

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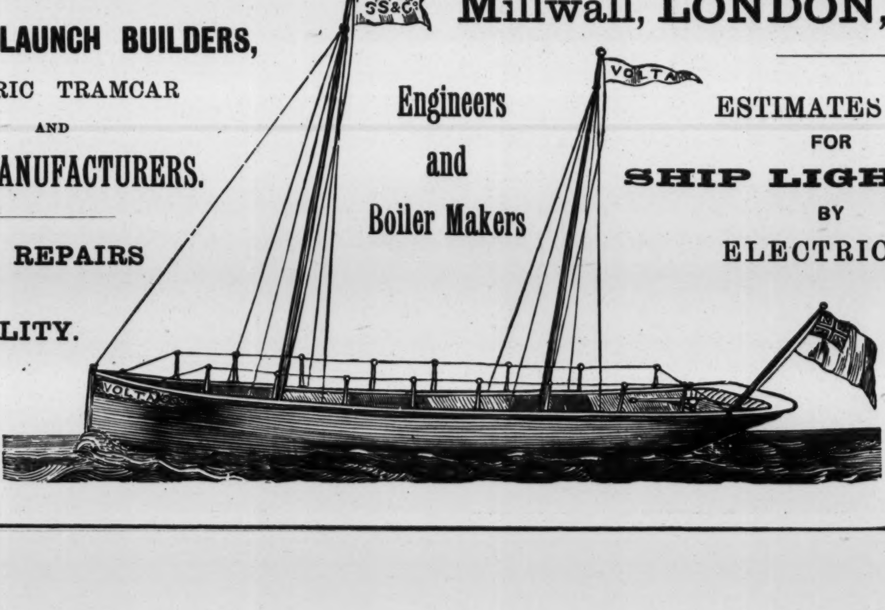

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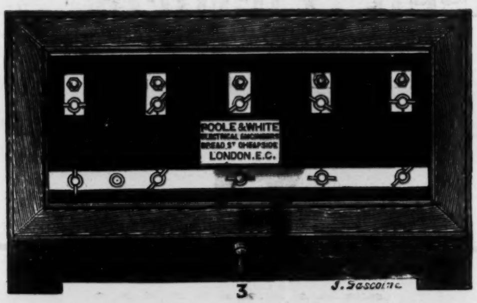

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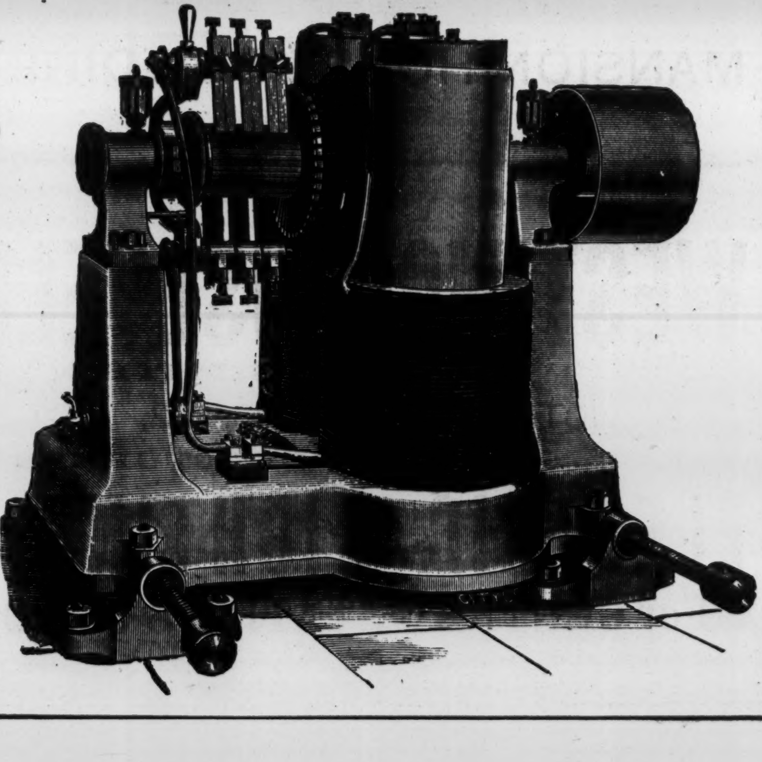

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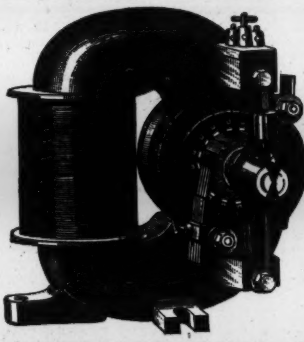

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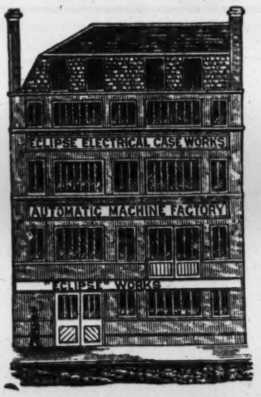

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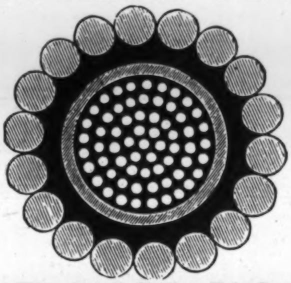

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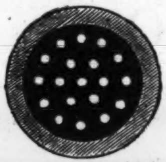

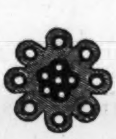

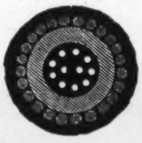

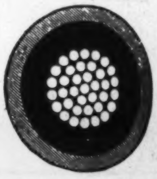

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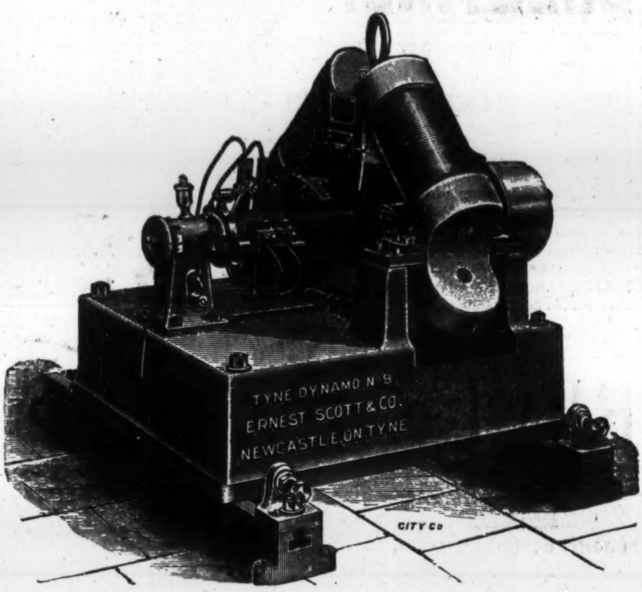

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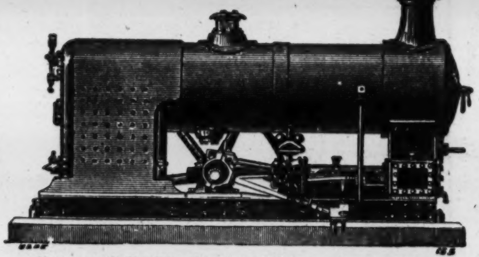
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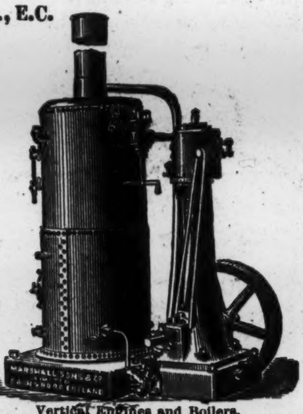
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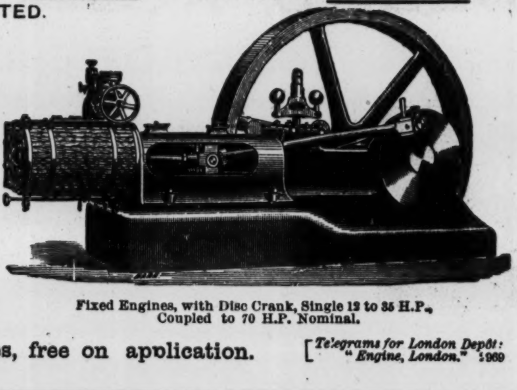
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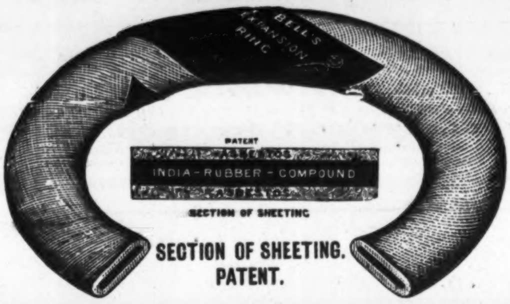

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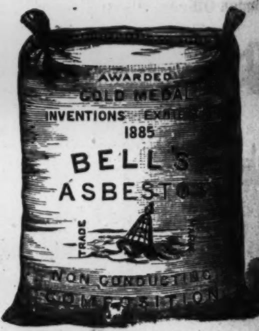

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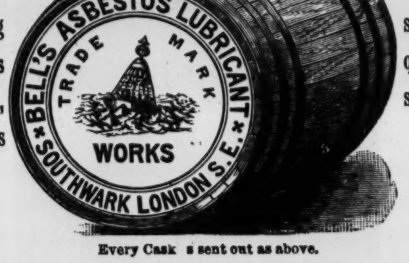

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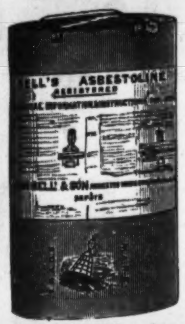

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DAGGER PACKING.

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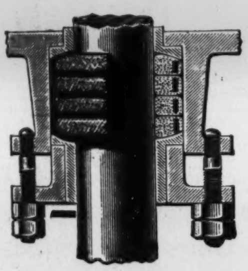

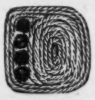

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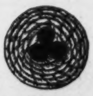

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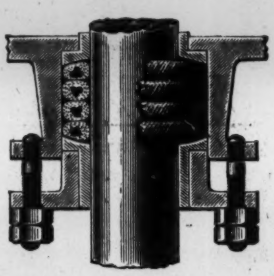

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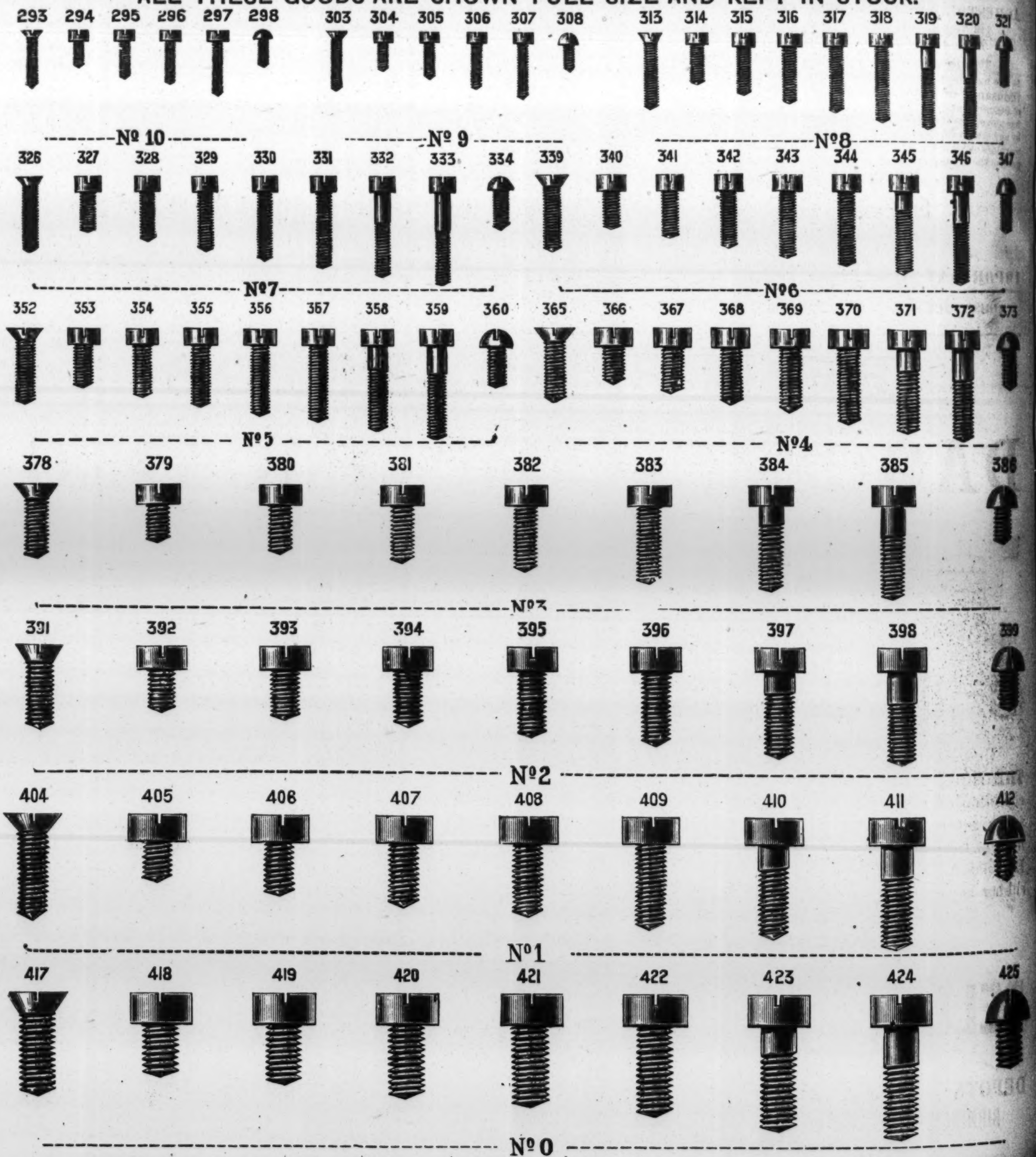

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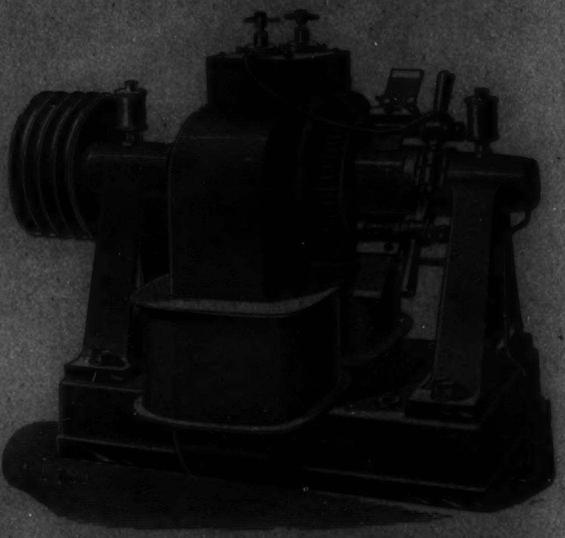

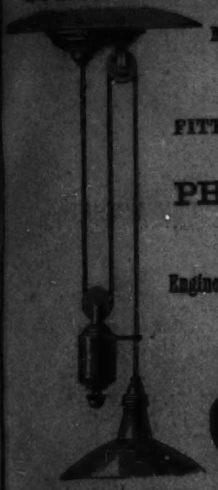

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